Results of NVG-induced neck strain questionnaire study in CH-146 Griffon aircrew

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Abstract

Night vision goggles (NVGs) have become indispensable during night operations in the tactical helicopter community of the Canadian Forces. However, the additional mass of the NVGs and associated counterweight have been suggested as a cause factor in recent reports of neck strain within the CH-146 Griffon helicopter fleet. The present study sought to determine the rate of incidence and severity of NVG-induced neck strain experienced by CH-146 Griffon pilots and flight engineers. A questionnaire format previously used in US and UK studies was presented to Griffon aircrew as well as CH-124 Sea King aircrew (the latter acting as an external control group with limited NVG experience). A total of 196 Griffon aircrew (138 pilots and 58 flight engineers) and 85 Sea King aircrew (35 pilots and 50 other aircrew) responded to the questionnaire. Over 80% of Griffon pilots and flight engineers indicated they had experienced neck pain as a result of flying, significantly greater proportions than the respective Sea King aircrew in both cases. Griffon pilots indicated that the control display unit of the aircraft was a leading cause of neck pain while flight engineers indicated that out-of-door operations were a primary cause factor. Other factors are identified and discussed. Across all aircrew respondents there was a clear sense of distrust of, and perhaps dissatisfaction with, the medical care provided by the Canadian Forces. Recommendations to reduce flight-related neck pain are offered.

Résumé

Les lunettes de vision nocturne (LVN) sont devenues indispensables lors d'opérations nocturnes menées à l'aide d'hélicoptères tactiques des Forces canadiennes. Toutefois, certains rapports récents sur les douleurs au cou ressenties par les équipages d'hélicoptères Griffon CH-146 ont suggéré que le poids et le contrepoids de ces lunettes constituent un facteur important de fatigue pour le cou. L'étude a cherché à déterminer le taux d'incidence et la gravité de la fatigue du cou imputables au port de LVN par les pilotes et par les mécaniciens de bord d'hélicoptères Griffon CH-146. Un questionnaire initialement utilisé aux États-Unis et au Royaume-Uni a été remis aux équipages du Griffon et du Sea King CH-124 (ce dernier groupe faisant fonction de groupe de contrôle externe, en raison de son expérience plutôt limitée du port de LVN). Un total de 196 membres d'équipages d'hélicoptères Griffon (138 pilotes et 58 mécaniciens de bord) et 85 membres d'équipages d'hélicoptères Sea King (35 pilotes et 50 autres préposés de bord) ont répondu au sondage. Plus de 80 % des pilotes et mécaniciens de bord du Griffon ont indiqué qu'ils avaient éprouvé des douleurs au cou à la suite d'un vol – une proportion considérablement plus grande que dans le cas des équipages du Sea King. Les pilotes du Griffon ont indiqué qu'en plus des LVN, l'unité de commande d'affichage de l'aéronef était pour eux cause majeure de douleurs au cou. De leur côté, les mécaniciens de bord ont surtout cité les opérations porte ouverte comme facteur causal principal. L'étude a aussi permis de constater parmi les répondants un scepticisme – voire même peut-être un mécontentement très net – envers les soins médicaux offerts par les Forces canadiennes. Le rapport contient diverses recommandations susceptibles d'aider à réduire les douleurs au cou

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Executive summary

Night vision goggles (NVGs) have become indispensable during night operations in the tactical helicopter community of the Canadian Forces. However, the additional mass of the NVGs and associated counterweight have been suggested as a cause factor in recent reports of neck strain within the CH-146 Griffon helicopter fleet. The present study sought to determine the rate of incidence and severity of NVG-induced neck strain experienced by CH-146 Griffon pilots and flight engineers.

A questionnaire format previously used in US and UK studies (obtained through contacts in Technical Cooperation Panel HUM TP-7 Human Factors in the Aviation Environment) was presented to Griffon aircrew as well as CH-124 Sea King aircrew (the latter acting as an external control group with limited NVG experience).

A total of 196 Griffon aircrew (138 pilots and 58 flight engineers) and 85 Sea King aircrew (35 pilots and 50 other aircrew) responded to the questionnaire. Over 80% of Griffon pilots and flight engineers indicated they had experienced neck pain as a result of flying, significantly greater proportions than the respective Sea King aircrew in both cases. In addition to NVG use, Griffon pilots indicated that the control display unit of the aircraft was a leading cause of neck pain while flight engineers indicated that out-of-door operations were a primary cause factor. Other factors contributing to neck pain as identified by both pilots and flight engineers included extended mission length or back-to-back missions, concentrations of flying or high operational tempo, general ergonomic issues with the airframe, instructor status, and the additional head supported mass of the NVGs making head movement challenging.

Approximately 10% of the pilots surveyed indicated that they had experienced neck pain during flight that was severe or incapacitating (i.e., at some point during flight their ability to safely pilot the aircraft disrupted or completely removed) presenting a clear flight safety concern.

In addition to neck pain there may be a significant issue with back pain in both the Griffon and Sea King fleets. Despite the rates of neck pain in both helicopter fleets, the proportion of aircrew seeking medical care was less than half. A clear sense of distrust of, and perhaps dissatisfaction with, the medical care provided by the Canadian Forces was common across all aircrew respondents.

Recommendations to reduce flight-related neck pain in Griffon aircrew include:

1. Increasing the number of instructors available or lengthen training courses to reduce the workload on instructors during the NVG portion of the courses;

2. Improvement of the relationship between aircrew and medical staff will result in earlier diagnosis and treatment, reducing the potential for long-term health effects of NVG use;

3. Moving the control display unit from it's current location to a position further up the console so that extreme forward flexion of the neck is not required to see or operate it;

4. More aggressive medical and physiotherapeutic care should be offered to mitigate the demanding and potentially damaging nature of out-of-door operations conducted by Griffon flight engineers;

5. Further studies (ideally longitudinal) of neck pain in aircrew should be conducted, especially as NVGs are integrated into more aircraft; and

6. Clearly directed research into the underlying mechanisms of neck pain is required in order to determine what countermeasures may be appropriate and feasible.

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Sommaire

Les lunettes de vision nocturne (LVN) sont devenues indispensables lors d'opérations nocturnes menées à l'aide d'hélicoptères tactiques des Forces canadiennes. Toutefois, certains rapports récents sur les douleurs au cou ressenties par les équipages d'hélicoptères Griffon CH-146 ont suggéré que le poids et le contrepoids de ces lunettes constituent un facteur important de fatigue pour le cou. L'étude a cherché à déterminer le taux d'incidence et la gravité de la fatigue du cou imputables au port de LVN par les pilotes et par les mécaniciens de bord d'hélicoptères Griffon CH-146.

Un questionnaire initialement utilisé aux États-Unis et au Royaume-Uni (obtenu par l'entremise de contacts dans le groupe d'experts en coopération technique HUM TP-7 sur l'ergonomie dans un environnement aéronautique) a été remis aux équipages du Griffon et du Sea King CH-124 (ce dernier groupe faisant fonction de groupe de contrôle externe, en raison de son expérience plutôt limitée du port de LVN).

Un total de 196 membres d'équipages d'hélicoptères Griffon (138 pilotes et 58 mécaniciens de bord) et 85 membres d'équipages d'hélicoptères Sea King (35 pilotes et 50 autres préposés de bord) ont répondu au sondage. Plus de 80 % des pilotes et mécaniciens de bord du Griffon ont indiqué qu'ils avaient éprouvé des douleurs au cou à la suite d'un vol – une proportion considérablement plus grande que dans le cas des équipages du Sea King. Les pilotes du Griffon ont indiqué qu'en plus des LVN, l'unité de commande d'affichage de l'aéronef était pour eux cause majeure de douleurs au cou. De leur côté, les mécaniciens de bord ont surtout cité les opérations porte ouverte comme facteur causal principal. Les autres facteurs cités par les pilotes et par les mécaniciens de bord comme responsables de douleurs au cou ont inclus la longueur des missions, la trop grande proximité de missions sans repos suffisant entre chacune d'elles, un effort de concentration en vol, une cadence opérationnelle trop précipitée, une mauvaise ergonomie de la cellule de l'aéronef, le statut d'instructeur, et le poids additionnel (le contrepoids) des LVN que doit supporter le cou et qui rend difficiles les mouvements de tête.

Environ 10 p. 100 des pilotes interrogés ont indiqué qu'ils avaient éprouvé des douleurs au cou intenses ou même incapacitantes en vol (à tel point qu'à un moment ou à un autre durant le vol, ces douleurs leur avait fait perdre – en tout ou en partie – leur capacité de piloter l'aéronef de manière sécuritaire) ce qui constitue évidemment une préoccupation majeure du point de vue sécurité en vol.

Une autre question importante est celle du mal de dos, tant à bord des hélicoptères Griffon que Sea King. En dépit des taux d'incidence élevés de douleurs au cou dans l'une et l'autre des flottes d'hélicoptères Griffon et Sea King, moins de la moitié des membres d'équipages ont demandé des soins médicaux. Le sondage a permis de constater parmi les répondants un scepticisme – voire même peut-être un mécontentement très net – envers les soins médicaux offerts par les Forces canadiennes.

Recommandations formulées pour réduire les douleurs au cou à bord d'aéronefs Griffon :

1. Accroissement du nombre d'instructeurs disponibles, ou extension de la durée des cours de formation, afin de réduire la charge de travail imposée aux instructeurs durant la portion du cours portant sur les LVN;

2. Une amélioration des rapports entre le personnel naviguant et les équipes médicales favoriserait un diagnostic et un traitement précoces et réduirait le risque de séquelles durables imputables au port de LVN;

3. Réinstallation de l'unité d'affichage des commandes en position plus haute au dessus de la console, afin d'éliminer le besoin de flexions extrêmes du cou vers l'avant pour lire l'afficheur ou pour utiliser l'unité;

4. Des soins médicaux et de physiothérapie plus agressifs devraient être offerts, afin de réduire la nature exigeante et possiblement dommageable des opérations porte ouverte exécutées par les mécaniciens de bord du Griffon;

5. Des études additionnelles (de préférence longitudinales) des douleurs au cou devraient être effectuées parmi les membres d'équipages, surtout que les LVN sont maintenant intégrées dans un plus grand nombre d'aéronefs;

6. Une recherche clairement ciblée sur les mécanismes sous-jacents de douleurs au cou est nécessaire pour déterminer quelles mesures correctives appropriées peuvent être prises et mises en œuvre.

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Introduction

Since the August 2001 Flight Safety Survey conducted by 1 Wing at 403 Squadron (Sqn) Gagetown the issue of neck strain has been a concern for the CH146 Griffon fleet. In the 403 Sqn survey the Unit Flight Safety Officer indicated that a number of pilots and flight engineers had complained of discomfort which was exacerbated while wearing night vision goggles (NVGs).

Defence Research and Development Canada Toronto was tasked by 1 Canadian Air Division Headquarters under project ALSE 2003-16 to investigate the issue of NVG-induced neck strain and report on the severity of the problem as well as possible ways to reduce or eliminate it. The scope of the project was to perform an anonymous survey and report on the results, as well as examining the state of the art in research with respect to neck strain in the rotary-wing environment. This report is a deliverable of that project.

Similar studies to the present one have been conducted in the UK and the US, with both countries utilizing a similar questionnaire. Information on these studies has not been published but they have been discussed under the Technical Cooperation Panel HUM TP-7 Human Factors in the Aviation Environment. The US questionnaire was obtained and modified for Canadian use, the rationale being that using a similar format would allow comparison between Canadian and US and UK data. The survey was intended to be exploratory, to quantify the problem and used to generate hypotheses regarding NVG-induced neck strain in order to direct further research.

Subsequent to the commencement of this project a Business Line 1 project to examine the issues of neck strain and loading across all aviation environments (i.e., fixed wing transport, fast jet and rotary wing) was approved and has commenced. The Business Line 1 project is much larger in scope and will undertake active research into the issue of neck loading and the short- and long-term health implications of such loading. As such, this report should be considered only a starting point in the effort to investigate, assess and ultimately advise on the issue of neck loading, with the Business Line 1 activity being considered the bulk of the effort.

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Literature review

The issue of neck injury in the aviation environment is not a new one. For a number of years the G-induced neck injuries of high performance fighter aircraft have been studied. Knudson et al. (1988) described the nature of injuries that could be incurred as a result of the high G-loading associated with aggressive manoeuvring in a high performance aircraft like the F/A-18.

Regarding neck pain in rotary-wing aircraft there appears to have been less research conducted despite a growing level of concern within operational communities. Canada is not alone in this regard. Studies similar to the present one have been conducted in the US and UK, with some discussion occurring in the Technical Cooperation Panel HUM TP-7 Human Factors in the Aviation Environment, but no formal results having been presented.

As part of their research initiative the US Army Aviation Research Laboratory commissioned a critical review of low severity neck injury. Kleinberger (2004) produced a thorough review of the state of the art in research, encompassing a review of the anatomy of the neck, epidemiology of neck and back injuries in military aviation, mechanisms of injury and related research. For a thorough understanding of the subject area it is recommended that the reader consult Kleinberger's report.

A full review of the anatomy of the neck is beyond the scope of this report, however a brief introduction is worthwhile. The neck or cervical spine is composed of seven vertebrae numbered C1 to C7, from top to bottom (C1 also being known as the atlas and C2 the axis). The soft tissue components of the cervical structures are complex and the musculature recruited varies depending on the position of the head and the form of motion involved. Ranges of motion are approximately 145 degrees of flexion/extension (flexion being a forward-downward "yes" motion and extension the backward-upward "yes" motion) and 180 degrees of rotation ("no" motion). Most rotation occurs at the C1-C2 joint while most flexion occurs equally along the C3-C7 joints (Kleinberger, 2004).

Harms-Ringdahl (1986, as cited in Kleinberger, 2004) calculated bending moments at the junction between C1 and the skull as well as the C7 to thoracic spine junction for five different positions: extreme flexion, slight flexion, neutral, chin tucked in and extreme extension. At the C1-skull juncture the neutral position generated a 1.3Nm moment while the extreme flexion moment was 1.5Nm. At the C7-thoracic joint the neutral position generated a moment of 1.2Nm while the extreme flexion position generated 4.3Nm. Note that in the neutral position the extensor muscles at the back of the neck are activated to keep the head up. Furthermore, these posterior neck extensor muscles are relatively massive compared to the anterior neck flexor muscles. Additionally, all of the above moment values are well below the moment that the neck can support, but it is important to note that additional head-supported mass could increase the moments to the extent that the moment is more than the posterior neck muscles can manage (Butler, 1997).

Several epidemiological studies of neck and spinal injury in military aircrew have been conducted over an extensive period of time. Besides the strain injuries associated with this

project the studies also detail the injuries resulting from all forms of mishap and accident. In particular a study conducted by Hodgdon et al (1997) is most relevant. In the study helicopter aviators from the US Navy were surveyed regarding neck and back pain within the last 30 flying days. Of the 195 respondents, 33.3% indicated back symptoms while 18.5% indicated neck symptoms (dull ache or sharp pain in the neck, or radiating pain, numbness or tingling in the arms). Back pain was more common in the H-53 and H-60 airframes (the former a heavy lift helicopter, the latter a lighter utility helicopter). Prevalence of neck symptoms was not significantly different across airframes. None of the airframes involved in the study were tactical helicopters (as is the CH-146 Griffon) although the H-3 Sea King shares it's lineage with the CH-124 Sea King. An interesting U-shaped relationship between flight hours and incidence of both back and neck pain was also noted in the study. Symptoms were at a minimum at 2000 to 3000 hours, but noticeably higher below and above that range. Back pain was significantly more prevalent in the younger respondents, while neck pain followed the same trend but without significance. No mention of NVG use is made in the report and it is unknown which of the airframes involved in the study routinely or occasionally involve NVG operations.

The mechanism (or mechanisms) of neck injury in helicopter pilots are not understood. Clearly helicopter pilots experience acute as well as chronic pain, however the relationship between acute, transient pain and the development of chronic pain or disability is not clear (Kleinberger 2004). According to Hodgdon et al (1997) the supporting muscles of the spine (including the posterior neck extensor muscles and anterior neck flexor muscles) are in a tonic (i.e., continuously contracted state) state during flight. This constant state of muscular contraction could possibly lead to damage of the intervertebral discs and therefore contribute to pain. Regarding lower back pain, Bowden (1995) suggests that postural fatigue (i.e., the maintenance of an awkward posture for a long period of time) may be the cause of acute back pain in helicopter pilots (as opposed to specific spinal injury). Given that the lower back pain experienced by the pilots is strongly associated with flight (as opposed to the lack of firm association of back pain with a particular cause in the general population) Bowden hypothesized that postural fatigue was the cause. Postural fatigue differs from muscle fatigue brought on by strong contractions in three ways:

1. the muscles involved are contracting at only a small fraction of the maximum voluntary contraction force;

2. fatigue manifests in muscle pain rather than reduction in muscle force; and

3. fatigue does not occur as rapidly as is usually the case in studies of sustained contractions.

No discussion of neck pain is made by Bowden, although it is assumed that postural fatigue might well be occurring in the neck as well as the lower back.

Kleinberger (2004) also notes that pilots maintain an extension of the upper neck and flexion of the lower neck for extended periods of time. As a result of this position the upper cervical spine musculature is continuously activated, creating increased cervical forces and moments that can be fatiguing. This stress is often maintained for longer periods of time than is desirable because the pilots are unable to easily change position while controlling the aircraft.

The painful accumulation of lactic acid in the muscles as a result of fatigue is immediate, whereas muscle soreness that occurs after flight is a response to overexertion and not fatigue.

Although whole-body vibration is associated with discomfort (Bowden, 1995), a study by Shanahan and Reading (1984) seems to indicate that in terms of helicopter pilots it is not significant. In the study a simulated UH-1H helicopter cockpit was "flown" by experienced pilots in two conditions: one where the vibration of the cockpit simulated the actual airframe and another where the cockpit did not vibrate. No significant differences between the two conditions were noted in terms of pain onset time or intensity of pain. Posture was therefore hypothesized to be the most important factor in the transient back pain experienced by the subjects. Neck pain was not reported in the study and it does not appear the NVGs were worn.

In terms of studies regarding head-supported mass, a number have been reported. In 1983 Phillips and Petrofsky conducted a series of experiments examining fatigue of the neck muscles in response to 30 minutes of lateral rotation under various head loads and centres of gravity (CG). Fatigue was measured by isometric endurance time. Three weights (3.2, 5.0 and 9.0 lbs) at five CG locations (forward-low, centre-low, high-high, right-lateral-low and aftward-high) were tested to represent various helmet and device configurations. NVGs tend to cause low-low CG while helmet mounted displays lead to a lateral shift in CG. Compared to a control of 0 lbs all conditions except the 3.2 lb/forward-low, 32.lb/right-lateral-low and 9.0 lb/aftward-low resulted in a significantly reduced endurance. The authors concluded that low helmet weights (approximately 3 lb) favour low-low and presumably both right- and left-low-low CG locations. For the more realistic 5 lb mass, there was no apparent physiologically optimal CG. When high head loads are necessary they suggested that redistribution of heavier components to the rear of the helmet and/or addition of weight to the rear of the helmet would produce the most favourable CG location. It is important to note that the positioning of the subject does not appear to match the extension of the upper neck and flexion of the lower neck described by Kleinberger (2004) as common in flying pilots. Furthermore, the distribution of weight to the rear of the helmet does not seem sensible if the initial fatiguing exercise is changed from lateral rotation to flexion and extension of the neck.

A study of young females with no neck pain history conducted by Harms-Ringdahl and Ekholm (1986, as cited in Kleinberger 2004) demonstrated that simply the weight of the head and neck maintained in an extreme forward flexion caused pain after several minutes. Subjects were able to sustain the position for several more minutes until they voluntarily stopped because of the severity of the pain. Once the position of the head was changed the pain diminished completely, although in some cases it reoccurred within the next 24 hours. Presumably the subsequent pain was indicative of an overexertion injury to the ligaments, connective tissues or muscle insertions in the neck region. Significant enough overexertion leading to failure and rupture of those structures would be expected to cause considerably longer periods of reoccurring pain.

Alem et al (1995) studied the effects of four different head-supported weight moments (20 [SPH4 helmet only], 110 [SPH4 and NVGs], 200 [H44 and counterweights] and 290 [SPH4, NVGs and M43 gas mask] N cm) on the performance of a target detection and acquisition task. The 12 helicopter pilots studied were exposed to four hour sessions of random vibration during which they were required to detect the illumination of random light emitting diodes and then acquire the target with a helmet-mounted light beam (a task similar to that performed

by AH-64 Apache pilots). There was no consistent relationship between duration of exposure and vigilance, however vigilance clearly did diminish as the weight moment increased. The shortest acquisition times occurred at 78 N cm based on a model fitting the data. The authors suggest that a small weight moment is actually beneficial as it can serve as a dampening force, attenuating the movement of the head in response to the whole body vibration.

A similar study was conducted by Butler and Alem in 1997 although this time the vibration profile simulated the UH-60 utility helicopter. Similar helmet configurations were used and exposure times were again four hours. Instead of a vigilance task, the subjects' head motion was tracked using a three-dimensional infrared tracking system attached to a bite plate. Head motion did not change with exposure duration for helmet torques of up to 90 N cm and durations of up to four hours. There was, however, an increase in head movement associated with an increase in helmet torque.

The most recent study conducted by Barazanji and Alem (2000) investigated head pitch and head accelerations for 12 different helmet configurations (three mass conditions by four CG locations) during sinusoidal vertical vibration having a magnitude of 0.45 m/s^2 and frequencies swept from 2 Hz to 17 Hz and back to 2 Hz at the rate of 0.25 Hz/sec. The resultant head pitch and axial accelerations were lower than male counterparts in previous studies. The results also showed differences in magnitude of head pitch acceleration between weight moments higher and lower than 91.3 ± 28.6 N cm, values comparable to the previously determined values of 82.8 ± 22.9 N cm recommended for their male counterparts. As such, the authors recommended that the design criteria of helmet supported device mass properties should not be gender sensitive.

Neither of the two studies above incorporated particularly awkward postures encountered in the CH-146 Griffon such as those associated with operating the control display unit (CDU). Furthermore, there was no mention in the literature of flight engineers (FEs) or similar crew in studies. Therefore, the peculiarities of the FEs duties have not likely been addressed by the research.

Based on the findings of the literature discussed above it is clear that there is a great deal that is not known regarding the mechanisms of neck injury and the role that head supported mass plays in those mechanisms. Although progress is being made much further research is required.

Survey methodology

The collection of survey data was performed as detailed in DRDC Toronto Ethics Protocol L-442 entitled "NVG-induced Neck Strain Questionnaire Study". As required by CF (Canadian Forces) policy this study also received approval from the DHRRE (Director Human Resources Research and Evaluation) Ethics Committee and was allocated survey coordination number 308/04.

The basis of the questionnaire was a US Army survey (itself based on a UK survey), obtained through US contacts on the Technical Cooperation Panel HUM TP-7 Human Factors in the Aviation Environment. The US Army survey was distributed to a number of different helicopter fleets to assess differences between the differing airframes and equipment configurations.

The US Army questionnaire was modified for Canadian use, the rationale being that using a similar format would allow comparison between Canadian and US and UK data. The survey was intended to be exploratory and used to generate hypotheses.

In order understand the issue of neck pain it is best to compare groups that flew and trained exactly the same, the only difference being that one group would use NVG whereas the other (control group) would not. In that way it would be most probable that any significant differences between neck strain or pain noted in the groups would be due to the one differing factor: NVGs. Unfortunately the vast majority of CH146 Griffon aircrew are experienced with NVG, therefore there is no way to use an internal control group. It was decided that the CH124 Sea King aircrew might offer a good external control group as the aircraft is not NVG compatible at this time (note that the Sea King is not NVG compatible in the cockpit although NVGs are used in the rear of the aircraft although to a much lesser extent than the Griffon). Furthermore, the deployment of Sea King crews ensures that they go through similar concentrations of flying during work up training and deployed operations as Griffon crews. It should be noted, however, that the roles of the Griffon and Sea King differ greatly (the former being a tactical helicopter in support of Army operations, the latter being a patrol and anti-submarine platform in support of naval operations), therefore these differences may confound any differences noted between the two groups of aircrew.

Because the duties of the pilots and other aircrew on board the Griffon and Sea King differ the intention was to compare the pilots and other aircrew separately. As such the pilots of both the Griffon and Sea King would be compared and then the Griffon FEs (Flight Engineers) and Sea King TACCO (Tactical Coordinator) and AESOP (Airborne Electronic Sensor Operator) were to be compared.

The survey was distributed in the period of 5 to 16 January 2004 in both English and French to 1 Wing (Kingston) and 12 Wing (Shearwater) units as follows:

- 1 Wing:
    - 400 Tactical Helicopter Squadron (Borden)

- 403 Helicopter Operational Training Squadron (Gagetown)
- 408 Tactical Helicopter Squadron (Edmonton)
- 427 Tactical Helicopter Squadron (Petawawa)
- 430 Escadron tactique d'hélicoptères (Valcartier)
- 438 Escadron tactique d'hélicoptères (St. Hubert)

- 12 Wing
  - 406 Maritime Operational Training Squadron (Shearwater)
  - 423 Maritime Helicopter Squadron (Shearwater)
  - Helicopter Operational Testing and Evaluation Facility (Shearwater)

A copy of the English questionnaire is included in Annex A.

From a statistical[1] standpoint the probability criterion (p) used in the analysis was the standard value of .05. With the large number of tests being conducted throughout the analysis the potential for false positive indications of significance exists, however since this study is exploratory in nature the adjustment of p value was not felt to be necessary.

[1] The statistical tests used compare the proportions or ratios of characteristics of the sample groups being compared. Therefore although there may be large differences in the absolute number metrics of a question it is the proportional difference (if any) that is of concern.

Results

The results of the survey are presented in the following sections. In order to provide a meaningful comparison between the CH146 Griffon and CH124 Sea King findings they will be presented in parallel. Additionally, the pilots are examined separately from the other aircrew (i.e., FE, TACCO and AESOP) as the duties are better matched in this way. Finally there were four mission specialists (from Griffon units) who responded to the survey but they are not included in this analysis as the small number of respondents would make any generalization of the findings highly questionable.

For each question or block of questions the number of respondents (n) is presented in the summary tables. Primarily this is due to the design of the questionnaire, which instructed respondents to skip certain sections based on their responses. As a result there are numerous questions where the number of respondents vary. A second reason for the inclusion of the n values is to account for some inconsistencies in the way the respondents filled in the questionnaire. Specifically, there were numerous cases where respondents neglected to respond to questions (e.g., commonly yes/no/not applicable questions were left blank) as well as several cases where respondents provided conflicting responses within the survey (e.g., at one point indicating that they had never experienced neck pain during flight and then later indicating that the worst episode of neck pain experienced was mild). In order to best represent the respondents it was decided to examine each question on an individual basis rather than attempting to determine the assumed responses for a given respondent. As a result there are cases where some conflict in the number of respondents exists between questions.

Pilots

A total of 175 respondents identified themselves as pilots of the CH146 Griffon or CH124 Sea King. Two of the surveys received were not included in this analysis as the respondents indicated that they were pilots but also indicated that they had no flying experience in either the Griffon or Sea King, therefore the number of surveys included in the analysis is 173.

General information and experience

The first portion of the questionnaire asked a number of questions to determine the background and experience of the respondents. Table 1 summarizes the characteristics of the pilot respondents as well as their general aviation, rotary wing and NVG experience as gathered in the first four pages of the questionnaire.

Table 1. General information and experience of pilots surveyed

	CH146 Griffon Pilots	CH124 Sea King Pilots
Number of respondents (n)	138	35
Gender	Male: 134 (97.1%) Female: 4 (2.9%)	Male: 34 (97.1%) Female: 1 (2.9%)
Age	Mean ± Std Dev: 36.4 ± 6.3	Mean ± Std Dev: 35.3 ± 5.9
Height (cm)	Mean ± Std Dev: 179.3 ± 6.3	Mean ± Std Dev: 180.2 ± 6.4
Weight (kg)	Mean ± Std Dev: 84.7 ± 11.8	Mean ± Std Dev: 88.1 ± 14.3
Years flying (since wings)	Mean ± Std Dev: 11.5 ± 7.1	Mean ± Std Dev: 11.4 ± 6.7
Total flying hours	Mean ± Std Dev: 2668 ± 1630	Mean ± Std Dev: 2652 ± 1254
Current instructor status	39 (28.3%)	12 (34.3%)
Total years in CH146/CH124 (respectively) [1]	Mean ± Std Dev: 4.9 ± 2.4	Mean ± Std Dev: 6.8 ± 4.8
Total hours in CH146/CH124 (respectively) [1]	Mean ± Std Dev: 1203 ± 888	Mean ± Std Dev: 1467 ± 845
NVG use	136 (98.5%)	8 (22.9%)
Total NVG hours [2]	Mean ± Std Dev: 172 ± 137	Mean ± Std Dev: 15 ± 45
NVG hours in last 28 days flying [2,3]	Mean ± Std Dev: 5.2 ± 6.3	No respondents had any hours in the last 28 days
Average NVG usage per flight [4]	Mean ± Std Dev: 1.9 ± 0.4	Mean ± Std Dev: 2.1 ± 0.2

[1] Respondents were requested to detail their experience with military rotary wing aircraft flown in the last 10 years, providing total hours and years flown (even in excess of the 10 year period). It appears that some may have misunderstood and responded with estimates of the hours and years within the 10 year period.

[2] These values reflect the NVG time logged in logbooks, which is the period of time spent looking through the goggles and does not include the additional time the NVGs are worn but not used (i.e., both before and after usage and work as backup to visual night flying). As a result the actual time spent with the additional weight of NVG supported by the neck is greater than the logbook value, but this value if not tracked and therefore cannot be accurately assessed.

[3] As most respondents were surveyed shortly after the Christmas leave period they were instructed to base their response on the last uninterrupted 28 day flying period prior to the Christmas leave period.

[4] The data presented reflects the values for only the members who indicated NVG use.

Comparing the two groups of pilots there were no significant differences in terms of gender distribution, age, height, weight, years flying and total flying hours. There was a significant difference in the number of years on their current airframe $t(171) = 2.91$, $p = .004$ with the

Sea King pilots having more experience in general, although this was not the case for the number of hours logged on their current airframe.

As the Sea King is not currently outfitted for NVG use in the cockpit it is not surprising that the Griffon pilot group had significantly higher proportion of NVG users as well as significantly more NVG hours, $X^2(1, N = 173) = 109.2, p < .001$ and $t(171) = 6.69, p < .001$ respectively. Even if only those pilots with NVG experience are compared with the Griffon pilots still had significantly more NVG hours, $t(141) = 2.26, p = .003$.

Recent experience with NVGs was not indicated by any Sea King pilots in contrast to the Griffon pilots. Finally the average NVG usage per flight of the groups was not significantly different.

Neck pain in pilots

This section details the results of the questionnaire from page five onward, dealing specifically with the issue of neck pain and injury. Table 2 summarizes the responses to questions regarding experience with neck pain unrelated to, as well as related to, flying.

Table 2. *Neck pain unrelated to and related to flying in pilots*

	CH146 Griffon Pilots n = 138		***CH124 Sea King Pilots n = 35***	
Have you ever experienced neck pain that was unrelated to flying?	Yes	No	Yes	No
	57 (41.3%)	81 (58.7%)	14 (40.0%)	21 (60.0%)
Have you ever experienced neck pain that was related to flying?	Yes	No	Yes	No
	112 (81.2%)	26 (18.8%)	13 (37.1%)	22 (62.9%)

The rate of neck pain reported unrelated to flying was not significantly different between the CH146 Griffon and CH124 Sea King pilot groups whereas the rate of neck pain reported related to flying was significantly different, $X^2(1, N = 173) = 26.98, p < .001$.

Respondents were then asked to indicate whether certain circumstances were associated with their (flight-related) neck pain. Table 3 summarizes the responses. Note that the data presented from this point on (unless stated otherwise) represents only those who responded to the questions concerned. Pilots who did not indicate experiences of neck pain related to flight were instructed to skip the remainder of the questionnaire.

Table 3. Circumstances associated with flight related neck pain in pilots

	CH146 Griffon Pilots	CH124 Sea King Pilots
Please indicate if you think your neck pain was associated with any of the following circumstances:	***n = 112***	***n = 13***
Student status	12 (10.7%)	2 (15.4%)
Instructor status	24 (21.4%)	1 (7.7%)
Infrequent flying duties	18 (16.1%)	0 (0%)
Recent illness	5 (4.5%)	1 (7.7%)

Although it appears that the Griffon pilots experienced more neck pain as a result of instructor status or infrequent flying duties when compared to the Sea King pilots this was not shown using statistical tests.

Neck pain during flight

This section examines the issue of neck pain experienced during flight. Table 4 details the rate of neck pain experienced by the pilots during flight. Note that the data presented in the table represents only those who responded to the question. Pilots who did not indicate experiences of neck pain related to flight were instructed to skip this section of the questionnaire.

Table 4. Neck pain during flight in pilots (those who indicated flight-related neck pain)

	CH146 Griffon Pilots n = 112		CH124 Sea King Pilots n = 16	
Have you ever experienced neck pain <u>during</u> flight?	Yes	No	Yes	No
	89 (79.5%)	23 (20.5%)	12 (75.0%)	4 (25.0%)

There was no statistically significant difference between the proportion of Griffon and Sea King pilots who had experienced neck pain during flight (of those who had indicated flight-related neck pain). If the number of "no" responses is raised to include those who did not fill out the remainder of the questionnaire after indicating no experiences of flight-related neck pain, the result is quite different. In that case the results are presented in Table 5.

Table 5. Neck pain during flight in pilots (all respondents)

	CH146 Griffon Pilots *n = 138*		*CH124 Sea King Pilots* *n = 35*	
Have you ever experienced neck pain during flight?	Yes	No	Yes	No
	89 (64.5%)	49 (35.5%)	12 (34.3%)	23 (65.7%)

With all respondents incorporated into the results there was a statistically significant difference in the proportion of pilots who had experienced neck pain during flight, X^2 (1, N = 173) = 10.48, $p < .002$, with the Griffon pilots having the higher proportion.

The number of incidents of neck pain experienced during flight by the pilots is summarized in Table 6.

Table 6. Episodes of neck pain during flight in pilots

	CH146 Griffon Pilots	*CH124 Sea King Pilots*
Please indicate the total number of episodes of neck pain you have experienced neck pain during flight:	***n = 86***	***n = 12***
1 episode	3 (3.5%)	1 (8.3%)
2-3 episodes	17 (19.8%)	4 (33.3%)
4-6 episodes	23 (26.7%)	3 (25.0%)
7-10 episodes	10 (11.6%)	0 (0%)
More than 10 episodes	33 (38.4%)	4 (33.3%)

No statistically significant difference was noted between the Griffon and Sea King pilots in terms of the distribution of percentages of frequencies of neck pain episodes.

Operating flight regime (i.e., normal and manoeuvring) and NVG use were then examined as factors in the neck pain experienced during flight. Respondents were requested to indicate their response from "Yes", "No" or "Not Applicable", however a number of respondents did not chose any of the three options. As a result Table 7

below summarizes the "Yes" responses and the n value indicated is taken from the number of respondents who indicated flight-related neck pain.

Table 7. *Factors associated with neck pain during flight in pilots*

	CH146 Griffon Pilots	***CH124 Sea King Pilots***
Which of the following factors was associated with your neck pain during flight?	***n = 89***	***n = 12***
Low G (normal flight) **without** NVGs	16 (18.0%)	9 (75.0%)
Low G (normal flight) **with** NVGs	58 (65.2%)	2 (16.7%)
Moderate G (2G) (manoeuvring) **without** NVGs	11 (12.4%)	3 (25.0%)
Moderate G (2G) (manoeuvring) **with** NVGs	33 (37.1%)	0 (0%)

Since a number of respondents did not indicate any of the three responses statistical analysis is not be possible as any attempt to generalize to a "No" or "Not Applicable" answer would not be guaranteed to represent the respondents accurately. However, it does appear that low and moderate G coupled with NVG use were associated with a greater number of incidents of neck pain during flight for Griffon pilots. Sea King pilots seem also to have a greater association of neck pain with non-NVG flight, especially at low G.

Neck pain after flight

Table 8 details the responses to the question of whether the pilots had experienced neck pain after flight.

Table 8. *Neck pain after flight in pilots (those who indicated flight-related neck pain)*

	CH146 Griffon Pilots n = 112		***CH124 Sea King Pilots n = 15***	
Have you ever experienced neck pain after flight?	Yes	No	Yes	No
	97 (86.6%)	15 (13.4%)	10 (66.7%)	5 (33.3%)

There was no statistically significant difference between the two groups of pilots. As before, if the number of "no" responses is raised to include those who did not fill out the remainder of the questionnaire after indicating no experiences of flight-related neck pain, the result changed somewhat. In that case the results are presented in Table 9.

Table 9. *Neck pain after flight in pilots (all respondents)*

	CH146 Griffon Pilots ***n = 138***		***CH124 Sea King Pilots*** ***n = 35***	
Have you ever experienced neck pain after flight?	Yes	No	Yes	No
	97 (70.3%)	41 (29.7%)	10 (28.6%)	25 (71.4%)

With all respondents incorporated into the results there was again a statistically significant difference in the proportion of pilots who had experienced neck pain after flight, X^2 (1, N = 173) = 20.59, $p < .001$, with the Griffon pilots having the higher proportion of experiences of neck pain once again.

The number of incidents of neck pain experienced by the pilots after flight is summarized in Table 10.

Table 10. *Episodes of neck pain after flight in pilots*

	CH146 Griffon Pilots	***CH124 Sea King Pilots***
Please indicate the total number of episodes of neck pain you have experienced neck pain after flight:	***n = 92***	***n = 9***
1 episode	5 (5.4%)	1 (11.1%)
2-3 episodes	23 (25.0%)	2 (22.2%)
4-6 episodes	14 (15.2%)	1 (11.1%)
7-10 episodes	9 (9.8%)	0 (0%)
More than 10 episodes	41 (44.6%)	5 (55.6%)

No statistically significant difference between the number of incidents of neck pain experienced after flight by the two groups was noted.

As before, the question regarding operating flight regime and NVG use required respondents to indicate their response from "Yes", "No" or "Not Applicable", however again a number of respondents did not chose any of the three options. As a result Table 11 below summarizes the "Yes" responses and the n value indicated is taken from the number of respondents who indicated flight-related neck pain.

Table 11. *Factors associated with neck pain after flight in pilots*

	CH146 Griffon Pilots	***CH124 Sea King Pilots***
Which of the following factors was associated with your neck pain after flight?	***n = 97***	***n = 10***
Low G (normal flight) **without** NVGs	18 (18.6%)	7 (70.0%)
Low G (normal flight) **with** NVGs	65 (67.0%)	1 (10.0%)
Moderate G (2G) (manoeuvring) **without** NVGs	16 (16.5%)	3 (30.0%)
Moderate G (2G) (manoeuvring) **with** NVGs	34 (35.1%)	0 (0%)

Again, since a number of respondents did not indicate any of the three responses statistical analysis is not be possible as any attempt to generalize to a "No" or "Not Applicable" answer would not be guaranteed to represent the respondents accurately. Regardless, it once again appears that low and moderate G coupled with NVG use were associated with a greater number of incidents of neck pain during flight for Griffon pilots while Sea King pilots s have a greater association of neck pain with non-NVG flight, especially at low G.

Severity and persistence of pain

The assessment of the severity of the pain experienced for the worst cases of pain during and after flight and average cases of pain during and after flight are summarized in Tables 12 and 13 below.

Table 12. Severity of worst episode of neck pain experienced during and after flight in pilots

	CH146 Griffon Pilots	CH124 Sea King Pilots
Please indicate the severity[1] of neck pain, for the worst episode of pain experienced during flight:	***n = 98***	***n = 13***
Mild	42 (42.9%)	4 (30.8%)
Moderate	41 (41.8%)	6 (46.2%)
Severe	12 (12.2%)	2 (15.4%)
Incapacitating	3 (3.1%)	1 (7.7%)
Please indicate the severity[1] of neck pain, for the worst episode of pain experienced after flight:	***n = 102***	***n = 12***
Mild	44 (43.1%)	5 (41.7%)
Moderate	34 (33.3%)	3 (25.0%)
Severe	19 (18.6%)	1 (8.3%)
Incapacitating	5 (4.9%)	3 (25.0%)

[1] Severity indicators were as follows
Mild - noticeable but did not interfere with normal duties
Moderate - difficult to concentrate on normal duties
Severe - disrupted ability to perform normal duties
Incapacitating - unable to perform normal duties

Table 13. *Average severity of neck pain experienced during and after flight in pilots*

	CH146 Griffon Pilots	***CH124 Sea King Pilots***
If you commonly experience neck pain, please indicate an average severity[1] of pain experienced during flight:	***n = 64***	***n = 6***
Mild	42 (65.6%)	4 (66.7%)
Moderate	19 (29.7%)	1 (16.7%)
Severe	1 (1.6%)	1 (16.7%)
Incapacitating	2 (3.1%)	0 (0%)
If you commonly experience neck pain, please indicate an average severity[1] of pain experienced after flight:	***n = 71***	***n = 7***
Mild	44 (62.0%)	3 (42.9%)
Moderate	20 (28.2%)	3 (42.9%)
Severe	6 (8.5%)	1 (14.3%)
Incapacitating	1 (1.4%)	0 (0%)

[1] Severity indicators were as follows:
Mild - noticeable but did not interfere with normal duties
Moderate - difficult to concentrate on normal duties
Severe - disrupted ability to perform normal duties
Incapacitating - unable to perform normal duties

No statistically significant differences in percentage were noted between the Griffon and Sea King pilots in terms of the four different questions regarding severity of pain summarized in the tables above.

The persistence of the pain experienced by the respondents is described in Table 14.

Table 14. Persistence of neck pain in pilots

	CH146 Griffon Pilots	CH124 Sea King Pilots
How long did the symptoms persist for the worst episode of neck pain?	***n = 109***	***n = 13***
During flight only	14 (12.8%)	3 (23.1%)
Less than 2 hours after flight	12 (11.0%)	0 (0%)
2-11 hours after flight	16 (14.7%)	2 (15.4%)
12-24 hours after flight	13 (11.9%)	1 (7.7%)
1-4 days after flight	31 (28.4%)	6 (46.2%)
More than 4 days after flight	23 (21.1%)	1 (7.7%)
How long do the symptoms usually persist for the average episode of neck pain?	***n = 105***	***n = 12***
During flight only	19 (18.1%)	2 (16.7%)
Less than 2 hours after flight	17 (16.2%)	1 (8.3%)
2-11 hours after flight	26 (24.8%)	3 (25.0%)
12-24 hours after flight	13 (12.4%)	4 (33.3%)
1-4 days after flight	20 (19.0%)	2 (16.7%)
More than 4 days after flight	10 (9.5%)	0 (0%)

No statistically significant differences in percentage were noted between the two groups of pilots in terms of persistence of symptoms of pain.

Treatment

This section details the findings from the questionnaire regarding what treatment, if any, the respondents had sought for their neck pain.

Table 15 details the proportion of pilots who sought treatment for their pain.

Table 15. Treatment sought by pilots

	CH146 Griffon Pilots n = 111		CH124 Sea King Pilots n = 15	
Have you ever sought treatment from a doctor or other consultant (e.g. physical therapist) for any occurrence of flight related neck pain?	Yes	No	Yes	No
	44 (39.6%)	67 (60.4%)	3 (20.0%)	12 (80.0%)

The proportion of pilots seeking treatment was not statistically different between the Griffon and Sea King respondents. The rather low numbers who sought treatment would seem to reinforce the notion that pilots are generally wary of seeking medical intervention for fear of being restricted to ground duties (i.e., grounding) or other influences on flight status. In fact, a number of respondents acknowledged an unwillingness to seek medical help for just such reasons.

Table 16 details the sources of medical treatment sought by the pilots, as well as the number of times they sought particular treatments.

Table 16. Providers of treatment sought by pilots

	CH146 Griffon Pilots n = 44		CH124 Sea King Pilots n = 3	
Who was the treatment sought from, and how many times:	Sought treatment	Number of times (Mean ± Std Dev)	Sought treatment	Number of times (Mean ± Std Dev)
Military doctor	35 (79.5%)	3.6 ± 5.3	3 (100.0%)	13.3 ± 5.8
Civilian doctor	4 (9.1%)	8.3 ± 14.5	1 (33.3%)	4.0 ± 0.0
Med A/Physician's Assistant	2 (4.5%)	1.0 ± 0.0	0 (0%)	—
Physical therapist	28 (63.6%)	8.0 ± 10.9	3 (100.0%)	73.3 ± 109.7
Chiropractor	15 (34.1%)	10.6 ± 15.0	2 (66.7%)	12.5 ± 3.5
Massage therapist	11 (25.0%)	12.5 ± 8.9	1 (33.3%)	100.0 ± 0.0
Acupuncturist	4 (9.1%)	3.8 ± 4.3	2 (66.7%)	7.0 ± 4.2
Other	3 (6.8%)	6.0 ± 5.7	0 (0%)	—

Statistical analysis of the providers of treatment to the pilots would provide little value, as such it was not performed. It is clear from the data, however, that both groups of pilots sought primarily the care of a military doctor and that therapeutic treatments (physiotherapeutic, chiropractic and massage therapy) were also prominently utilized.

Next the respondents were asked to indicate whether or not they had received any treatment for their neck pain as well as whether or not they had been grounded. The responses to the former question may not be reliable as a number of respondents indicated that they had not received satisfactory treatment (in their opinion) which was not the intent of the question.

Table 17. *Provision of treatment and grounding of pilots*

	CH146 Griffon Pilots		***CH124 Sea King Pilots***	
Were you given any treatment for your neck pain?	***n = 44***		***n = 3***	
	Yes	No	Yes	No
	33 (75.0%)	11 (25.0%)	3 (100.0%)	0 (0%)
Have you ever been grounded as a result of flight related neck pain?	***n = 101***		***n = 14***	
	Yes	No	Yes	No
	16 (15.8%)	85 (84.2%)	2 (14.3%)	12 (85.7%)

There were no statistically significant differences between the groups (as percentages). As noted earlier, a number of pilots (all Griffon pilots) indicated that they did not receive treatment.

Comments

Within the questionnaire there were numerous areas for respondents to provide comments on their responses or simply to express their opinions in general. Table 18 summarizes some of the comments made by pilots that they indicated were directly related to neck injury. Note that the percentages are based on all respondents and not just those who indicated neck pain. Annex B contains the comments made by five Griffon pilots that present a range of the comments made by the pilots.

Table 18. Comments regarding neck pain in pilots

	CH146 Griffon Pilots	CH124 Sea King Pilots
Comment	**n = 138**	**n = 35**
Looking down to view/operate CDU, centre console or map on lap	76 (55.1%)	1 (2.9%)
Extended flying hours in a single day/night (i.e., extended flights, multiple flights per day/night)	25 (18.1%)	3 (8.6%)
General poor postures caused by cockpit ergonomics and task requirements	24 (17.4%)	6 (17.1%)
Continuous head movement (scanning) and static neck postures required in hovering, clearances etc.	22 (15.9%)	2 (5.7%)
Concentrations of flying as little as a few days in succession (i.e., workups, deployments, etc).	19 (13.8%)	1 (2.9%)
Back pain present	11 (8.0%)	4 (11.4%)
Weight of kit (i.e., helmet and NVG if applicable)	9 (6.5%)	3 (8.6%)
Rapid head movements	9 (6.5%)	0 (0%)
Vibration	9 (6.5%)	3 (8.6%)
Instructor pilot status	7 (5.1%)	0 (0%)
Time off (months) from NVG use	6 (4.3%)	0 (0%)
Cold air on neck	3 (2.2%)	0 (0%)
Raising head from forward (i.e., downward) flexion	2 (1.4%)	0 (0%)
Counterweight	1 (0.7%)	0 (0%)

Other aircrew

A total of 110 surveys were received from aircrew who identified themselves as CH146 FEs or CH124 TACCOs or AESOPs. Of that number two surveys were not included in the analysis as one had no rotary wing experience and the other had only one hour of experience on the airframe. As such, the analysis of the surveys includes only 108 respondents.

General information and experience

The following table (Table 19) summarizes the characteristics of the other aircrew respondents as well as their general aviation, rotary wing and NVG experience as gathered in the first four pages of the questionnaire.

Table 19. *General information and experience of other aircrew surveyed*

	CH146 Griffon FEs	***CH124 Sea King TACCOs and AESOPs***
Number of respondents (n)	58	50
Gender	Male: 57 (98.3%) Female: 1 (1.7%)	Male: 46 (92.0%) Female: 4 (8.0%)
Age	Mean ± Std Dev: 39.1 ± 4.4	Mean ± Std Dev: 36.1 ± 6.1
Height (cm)	Mean ± Std Dev: 177.9 ± 6.4	Mean ± Std Dev: 178.6 ± 9.2
Weight (kg)	Mean ± Std Dev: 86.2 ± 10.7	Mean ± Std Dev: 87.3 ± 12.9
Years flying (since wings)	Mean ± Std Dev: 7.1 ± 6.3	Mean ± Std Dev: 10.8 ± 6.1
Total flying hours	Mean ± Std Dev: 1778 ± 1828	Mean ± Std Dev: 1859 ± 1306
Current instructor status	17 (29.3%)	14 (40.0%)
Total years in CH146/CH124 (respectively) [1]	Mean ± Std Dev: 3.9 ± 2.4	Mean ± Std Dev: 6.3 ± 4.5
Total hours in CH146/CH124 (respectively) [1]	Mean ± Std Dev: 967.4 ± 621	Mean ± Std Dev: 1034 ± 680
NVG use	58 (100%)	40 (80.0%)
Total NVG hours [2]	Mean ± Std Dev: 166 ± 125	Mean ± Std Dev: 12 ± 15
NVG hours in last 28 days flying [2,3]	Mean ± Std Dev: 5.5 ± 4.9	Mean ± Std Dev: 0.4 ± 1.8
Average NVG usage per flight [4]	Mean ± Std Dev: 1.9 ± 0.4	Mean ± Std Dev: 1.3 ± 0.9

[1] Respondents were requested to detail their experience with military rotary wing aircraft flown in the last 10 years, providing total hours and years flown (even in excess of the 10 year period). It appears that some may have misunderstood and responded with estimates of the hours and years within the 10 year period.

[2] These values reflect the NVG time logged in logbooks, which is the period of time spent looking through the goggles and does not include the additional time the NVGs are worn but not used (i.e., both before and after usage and work as backup to visual night flying). As a result the actual time spent with the additional weight of NVG supported by the neck is greater than the logbook value, but this value if not tracked and therefore cannot be accurately assessed.

[3] As most respondents were surveyed shortly after the Christmas leave period they were instructed to base their response on the last uninterrupted 28 day flying period prior to the Christmas leave period.

[4] The data presented reflects the values for only the members who indicated NVG use.

Comparing the two groups of other aircrew, they were not as well matched as the pilot groups. Although there were no significant differences noted in terms of gender, height or weight,

there was a significant difference in terms of age, $t(106) = 3.01$, $p = .003$, with the Griffon FEs being older than the Sea King other aircrew. Furthermore, there was a significant difference in number of years flying and the number of years flying on their current airframe, $t(106) = 3.05$, $p = .003$ and $t(106) = 3.70$, $p < .001$ respectively, with the Sea King other aircrew having flown for more years although there was no significant difference between the groups in terms of total flying hours or flying hours on their current airframe.

Comparing NVG experience, the proportion of Sea King other aircrew who had used NVGs was significantly lower than the Griffon FEs, X^2 (1, N = 108) = 12.78, $p < .001$. The Griffon FEs also had significantly more NVG hours and NVG hours in the last 28 days, $t(106) = 8.62$, $p < .001$, and $t(106) = 6.95$ and $p < .001$ respectively. Even when only those Sea King other aircrew with NVG experience were compared to the Griffon FEs they still had significantly fewer numbers of NVG hours and NVG hours in the last 28 days, $t(91) = 7.28$, $p < .001$ and $t(90) = 5.75$, $p < .001$ respectively.

Neck pain in other aircrew

The remainder of the questionnaire concerned neck pain, starting with respondents being asked to indicate any experiences of neck pain that were unrelated to flying as well as those that they believed were related to flight. Table 20 summarizes the responses.

Table 20. *Neck pain unrelated to and related to flying in other aircrew*

	CH146 Griffon FEs		***CH124 Sea King TACCOs and AESOPs***	
Have you ever experienced neck pain that was unrelated to flying?	***n = 57***		***n = 50***	
	Yes	No	Yes	No
	10 (17.5%)	47 (82.5%)	21 (42.0%)	29 (58.0%)
Have you ever experienced neck pain that was related to flying?	***n = 58***		***n = 50***	
	Yes	No	Yes	No
	49 (84.5%)	9 (15.5%)	23 (46.0%)	27 (54.0%)

Comparing experiences of neck pain unrelated to flight the Griffon FEs had a significantly lower proportion of yes responses than the Sea King other aircrew, X^2 (1, N = 107) = 7.74, $p < .006$. When examining the experiences of neck pain related to flight the situation was reversed, with significantly larger proportion of Griffon FEs experiencing neck pain than the Sea King other aircrew, X^2 (1, N = 108) = 17.89, $p < .001$.

Subsequently the survey asked respondents to indicate if certain circumstances were associated with the flight-related neck pain. The responses are summarized in Table 21. Note

that the data presented from this point on (unless otherwise stated) represents only those who responded to the questions concerned. Other aircrew who did not indicate experiences of neck pain related to flight were instructed to skip the remainder of the questionnaire.

Table 21. *Circumstances associated with flight related neck pain in other aircrew*

	CH146 Griffon FEs	***CH124 Sea King TACCOs and AESOPs***
Please indicate if you think your neck pain was associated with any of the following circumstances:	***n = 49***	***n = 23***
Student status	2 (4.1%)	0 (0%)
Instructor status	6 (12.2%)	2 (8.7%)
Infrequent flying duties	7 (14.3%)	3 (13.0%)
Recent illness	2 (4.1%)	0 (0%)

Comparing between the Griffon and Sea King groups there were no significant differences (in percentages) noted for any of the four circumstances.

Neck pain during flight

Table 22 details the response to the question of whether the other aircrew had experienced neck pain during flight.

Table 22. *Neck pain during flight in other aircrew (those who indicated flight-related neck pain)*

	CH146 Griffon FEs n = 48		***CH124 Sea King TACCOs and AESOPs n = 22***	
Have you ever experienced neck pain during flight?	Yes	No	Yes	No
	39 (81.2%)	9 (18.8%)	17 (73.9%)	5 (21.7%)

There was no statistically significant difference between the proportion of other aircrew in the Griffon and Sea King who had experienced neck pain during flight (of those who had indicated flight-related neck pain). If the number of "no" responses is

raised to include those who did not fill out the remainder of the questionnaire after indicating no experiences of flight-related neck pain, the result is quite different. In that case the results are presented in Table 23.

Table 23. *Neck pain during flight in other aircrew (all respondents)*

	CH146 Griffon FEs ***n = 58***		***CH124 Sea King TACCOs and AESOPs*** ***n = 50***	
Have you ever experienced neck pain during flight?	Yes	No	Yes	No
	39 (67.2%)	19 (32.8%)	17 (34.0%)	33 (66.0%)

With all respondents incorporated into the results there was a statistically significant difference in the proportion of other aircrew who had experienced neck pain during flight, X^2 (1, N = 108) = 11.88, $p < .001$, with the Griffon FEs having the higher proportion.

The number of incidents of neck pain experienced during flight by the other aircrew is summarized in Table 24.

Table 24. *Episodes of neck pain during flight in other aircrew*

	CH146 Griffon FEs	***CH124 Sea King TACCOs and AESOPs***
Please indicate the total number of episodes of neck pain you have experienced neck pain during flight:	***n = 38***	***n = 17***
1 episode	1 (2.6%)	0 (0%)
2-3 episodes	8 (21.1%)	3 (17.6%)
4-6 episodes	6 (15.8%)	3 (17.6%)
7-10 episodes	6 (15.8%)	2 (11.8%)
More than 10 episodes	17 (44.7%)	9 (52.9%)

No statistically significant difference between the number of incidents of neck pain experienced by the two groups was noted.

The next question regarding operating flight regime and NVG use required respondents to indicate their response from "Yes", "No" or "Not Applicable", however a number of respondents did not chose any of the three options. As a result Table 25 below summarizes the "Yes" responses and the n value indicated is taken from the number of respondents who indicated flight-related neck pain.

Table 25. Factors associated with neck pain during flight in other aircrew

	CH146 Griffon FEs	*CH124 Sea King TACCOs and AESOPs*
Which of the following factors was associated with your neck pain during flight?	***n = 39***	***n = 17***
Low G (normal flight) **without** NVGs	4 (10.3%)	8 (47.1%)
Low G (normal flight) **with** NVGs	26 (66.7%)	6 (35.3%)
Moderate G (2G) (manoeuvring) **without** NVGs	8 (20.5%)	3 (17.6%)
Moderate G (2G) (manoeuvring) **with** NVGs	21 (53.8%)	2 (11.8%)

Since a number of respondents did not indicate any of the three responses statistical analysis is not be possible as any attempt to generalize to a "No" or "Not Applicable" answer would not be guaranteed to represent the respondents accurately. Regardless, it does appear that a higher proportion of Griffon FEs felt that NVG use coupled with normal and moderate G were associated with the incidence of neck strain.

Neck pain after flight

Table 26 details the responses to the question of whether other aircrew had experienced neck pain after flight.

Table 26. Neck pain after flight in other aircrew

	CH146 Griffon FEs n = 49		CH124 Sea King TACCOs and AESOPs n = 21	
Have you ever experienced neck pain after flight?	Yes	No	Yes	No
	48 (98.0%)	1 (2.0%)	14 (66.7%)	7 (33.3%)

The data indicates that Griffon FEs experienced a significantly greater proportion of neck pain after flight (of those who had indicated flight-related neck pain) than Sea King other aircrew, X^2 (1, N = 70) = 14.22, $p < .001$. As before, if the number of "no" responses is raised to include those who did not fill out the remainder of the questionnaire after indicating no experiences of flight-related neck pain, the result is changed somewhat. In that case the results are presented in Table 27.

Table 27. Neck pain after flight in other aircrew

	CH146 Griffon FEs n = 58		CH124 Sea King TACCOs and AESOPs n = 50	
Have you ever experienced neck pain after flight?	Yes	No	Yes	No
	48 (82.8%)	10 (17.2%)	14 (28.0%)	36 (72.0%)

With all respondents incorporated into the results there was again a statistically significant difference in the proportion of other aircrew who had experienced neck pain after flight, X^2 (1, N = 108) = 32.93, $p < .001$, with the Griffon FEs having the higher proportion once again.

The number of incidents of neck pain experienced after flight by the other aircrew is summarized in Table 28.

Table 28. Episodes of neck pain after flight in other aircrew

	CH146 Griffon FEs	CH124 Sea King TACCOs and AESOPs
Please indicate the total number of episodes of neck pain you have experienced neck pain after flight:	***n = 43***	***n = 12***
1 episode	1 (2.3%)	0 (0%)
2-3 episodes	5 (11.6%)	1 (8.3%)
4-6 episodes	7 (16.3%)	2 (16.7%)
7-10 episodes	5 (11.6%)	0 (0%)
More than 10 episodes	25 (58.1%)	9 (75.0%)

No statistically significant difference between the number of incidents of neck pain experienced after flight by the two groups (as a percentage) was noted.

As before, the question regarding operating flight regime and NVG use required respondents to indicate their response from "Yes", "No" or "Not Applicable", however, a number of respondents did not chose any of the three options. As a result Table 29 below summarizes the "Yes" responses and the n value indicated is taken from the number of respondents who indicated flight-related neck pain.

Table 29. Factors associated with neck pain after flight in other aircrew

	CH146 Griffon FEs	CH124 Sea King TACCOs and AESOPs
Which of the following factors was associated with your neck pain after flight?	***n = 48***	***n = 14***
Low G (normal flight) **without** NVGs	9 (18.8%)	6 (42.9%)
Low G (normal flight) **with** NVGs	27 (56.3%)	3 (21.4%)
Moderate G (2G) (manoeuvring) **without** NVGs	9 (18.8%)	3 (21.4%)
Moderate G (2G) (manoeuvring) **with** NVGs	25 (52.1%)	1 (7.1%)

Since a number of respondents did not indicate any of the three responses statistical analysis is not be possible as any attempt to generalize to a "No" or "Not Applicable" answer would not be guaranteed to represent the respondents accurately. Regardless, it does appear that a higher proportion of Griffon FEs felt that NVG use coupled with normal and moderate G were associated with the incidence of neck pain while a higher proportion of Sea King other aircrew felt that low G flight without NVG was associated with their neck pain.

Severity and persistence of pain

The assessment of the severity of the pain experienced for the worst cases of pain during and after flight and average cases of pain during and after flight are summarized in Tables 30 and 31 below.

Table 30. *Severity of worst episode of neck pain experienced during and after flight in other aircrew*

	CH146 Griffon FEs	***CH124 Sea King TACCOs and AESOPs***
Please indicate the severity[1] of neck pain, for the worst episode of pain experienced during flight:	***n = 40***	***n = 19***
Mild	16 (40.0%)	5 (26.3%)
Moderate	18 (45.0%)	12 (63.2%)
Severe	5 (12.5%)	2 (10.5%)
Incapacitating	1 (2.5%)	0 (0%)
Please indicate the severity[1] of neck pain, for the worst episode of pain experienced after flight:	***n = 46***	***n = 15***
Mild	14 (30.4%)	5 (33.3%)
Moderate	20 (43.5%)	4 (26.7%)
Severe	11 (23.9%)	3 (20.0%)
Incapacitating	1 (2.2%)	3 (20.0%)

[1] Severity indicators were as follows:
Mild - noticeable but did not interfere with normal duties
Moderate - difficult to concentrate on normal duties
Severe - disrupted ability to perform normal duties
Incapacitating - unable to perform normal duties

Table 31. Average severity of neck pain experienced during and after flight in other aircrew

	CH146 Griffon FEs	CH124 Sea King TACCOs and AESOPs
If you commonly experience neck pain, please indicate an average severity[1] of pain experienced during flight:	***n = 31***	***n = 15***
Mild	19 (61.3%)	11 (73.3%)
Moderate	11 (35.5%)	4 (26.7%)
Severe	1 (3.2%)	0 (0%)
Incapacitating	0 (0%)	0 (0%)
If you commonly experience neck pain, please indicate an average severity[1] of pain experienced after flight:	***n = 35***	***n = 10***
Mild	15 (42.9%)	4 (40.0%)
Moderate	17 (48.6%)	5 (50.0%)
Severe	3 (8.6%)	1 (10.0%)
Incapacitating	0 (0%)	0 (0%)

[1] Severity indicators were as follows:
Mild - noticeable but did not interfere with normal duties
Moderate - difficult to concentrate on normal duties
Severe - disrupted ability to perform normal duties
Incapacitating - unable to perform normal duties

No statistically significant differences were noted between the Griffon FEs and Sea King other aircrew in terms of the four different questions regarding severity of pain summarized in the tables above.

The persistence of the pain experienced by the respondents is described in Table 32.

Table 32. Persistence of neck pain in other aircrew

	CH146 Griffon FEs	CH124 Sea King TACCOs and AESOPs
How long did the symptoms persist for the worst episode of neck pain?	***n = 49***	***n = 20***
During flight only	0 (0%)	4 (20.0%)
Less than 2 hours after flight	3 (6.1%)	4 (20.0%)
2-11 hours after flight	17 (34.7%)	6 (30.0%)
12-24 hours after flight	6 (12.2%)	2 (10.0%)
1-4 days after flight	15 (30.6%)	3 (15.0%)
More than 4 days after flight	8 (16.3%)	1 (5.0%)
How long do the symptoms usually persist for the average episode of neck pain?	***n = 47***	***n = 20***
During flight only	1 (2.1%)	5 (25.0%)
Less than 2 hours after flight	11 (23.4%)	7 (35.0%)
2-11 hours after flight	15 (31.9%)	4 (20.0%)
12-24 hours after flight	6 (12.8%)	1 (5.0%)
1-4 days after flight	9 (19.1%)	2 (10.0%)
More than 4 days after flight	5 (10.6%)	1 (5.0%)

For both questions regarding persistence of symptoms of neck pain there were significant differences between the distributions of responses. In the first case, regarding the worst episode, the difference, X^2 (5, N = 69) = 15.38, $p < .009$, seems to be that the Griffon FEs reported less experiences in the first two persistence categories (during flight only and less than 2 hours after flight) and more in the last two (1-4 days after flight and more than 4 days after flight). Similarly in response to the question regarding the average episode the difference, X^2 (5, N = 67) = 11.62, $p < .041$, appears to be that Griffon FEs experiences were less in the first two persistence categories and greater in the last four persistence categories. Overall this would indicate that the Griffon FEs are experiencing longer lasting pain episodes both in terms of the worst case and the average case.

Treatment

This section details the findings from the questionnaire regarding what treatment, if any, the respondents sought for their neck pain.

Table 33 describes the proportion of other aircrew who sought treatment for their pain.

Table 33. *Treatment sought by other aircrew*

	CH146 Griffon FEs ***n = 49***		***CH124 Sea King TACCOs and AESOPs*** ***n = 20***	
Have you ever sought treatment from a doctor or other consultant (e.g. physical therapist) for any occurrence of flight related neck pain?	Yes	No	Yes	No
	22 (44.9%)	27 (55.1%)	5 (25.0%)	15 (75.0%)

There was no significant difference in the number of Griffon FEs and Sea King other aircrew in terms of proportion seeking treatment. The relatively low numbers of other aircrew who sought treatment would seem to reinforce the notion that aircrew are generally unwilling to seek medical intervention for fear of grounding or other influences on flight status. As with the pilots, a number of respondents acknowledged an unwillingness to seek medical help for just such reasons.

Table 34 details the sources of medical treatment sought by the other aircrew, as well as the number of times they sought particular treatments.

Table 34. Providers of treatment sought by other aircrew

	CH146 Griffon FEs n = 22		CH124 Sea King TACCOs and AESOPs n = 5	
Who was the treatment sought from, and how many times:	Sought treatment	Number of times (Mean ± Std Dev)	Sought treatment	Number of times (Mean ± Std Dev)
Military doctor	16 (72.7%)	4.4 ± 5.0	5 (100.0%)	5.4 ± 3.0
Civilian doctor	4 (18.2%)	2.7 ± 1.5	0 (0%)	—
Med A/Physician's Assistant	0 (0%)	—	0 (0%)	—
Physical therapist	10 (45.5%)	17.1 ± 21.9	4 (80.0%)	6.3 ± 4.3
Chiropractor	7 (31.8%)	14.8 ± 6.1	0 (0%)	—
Massage therapist	3 (13.6%)	6.3 ± 4.0	0 (0%)	—
Acupuncturist	2 (9.1%)	6.5 ± 4.9	1 (20.0%)	15.0 ± 0.0
Other	0 (0%)	—	0 (0%)	—

As with the pilots, statistical analysis of the providers of treatment to the other aircrew would provide little value, therefore it was not performed. It is clear from the data, however, that both groups sought primarily the care of a military doctor; however, physiotherapeutic treatments seemed to be more popular with the Sea King other aircrew while a small proportion of Griffon FEs sought the care of civilian doctors, chiropractors and massage therapists.

Next the respondents were asked to indicate whether or not they had received any treatment for their neck pain as well as whether or not they had been grounded. As with the pilots the responses to the first question may not be reliable as a some respondents indicated that they had not received satisfactory treatment (in their opinion) which was not the intent of the question.

Table 35. Provision of treatment and grounding of other aircrew

	CH146 Griffon FEs		CH124 Sea King TACCOs and AESOPs	
Were you given any treatment for your neck pain?	n = 25		n = 5	
	Yes	No	Yes	No
	17 (68.0%)	8 (32.0%)	4 (80.0%)	1 (20%)
Have you ever been grounded as a result of flight related neck pain?	n = 17		n = 14	
	Yes	No	Yes	No
	10 (55.8%)	7 (41.2%)	4 (28.6%)	10 (71.4%)

There were no statistically significant differences between the groups.

Comments

Within the questionnaire there were numerous areas for respondents to provide comments on their responses or simply to express their opinions in general. Table 36 summarizes some of the comments made by the other aircrew that they indicated were directly related to neck injury. Note that the percentages are based on all respondents and not just those who indicated neck pain. Annex C contains the comments made by four Griffon FEs that present a range of the comments made by the other aircrew.

Table 36. Comments regarding neck pain in other aircrew

	CH146 Griffon FEs	CH124 Sea King TACCOs and AESOPs
Comment	**n = 58**	**n = 50**
Operations with head out of side/rear door (i.e., slopes, clearances, hoisting, slinging)	34 (58.6%)	13 (26%)
Extended flying hours in a single day/night (i.e., extended flights, multiple flights per day/night)	13 (22.4%)	1 (2%)
High operational tempo, concentrations of flying (i.e., workups, deployments, etc).	10 (17.2%)	3 (6%)
Weight of kit (i.e., helmet and NVG if applicable)	10 (17.2%)	5 (10%)
Instructor status	9 (15.5%)	1 (2%)
Rapid or continuous head movements	9 (15.5%)	0 (0%)
General poor postures caused by crewstation ergonomics and task requirements	8 (13.8%)	5 (10%)
Back pain present	6 (10.3%)	1 (2%)
Cold air/windblast	5 (8.6%)	3 (6%)
Tactical flying	5 (8.6%)	0 (0%)
Vibration	3 (5.2%)	0 (0%)
Low cabin height	3 (5.2%)	2 (4%)
Moving around rear of aircraft	2 (3.4%)	2 (4%)
Seating	2 (3.4%)	0 (0%)

Discussion

As with the results this section will first examine the pilots and then concentrate on the other aircrew. The emphasis will be on differences between the Griffon and Sea King aircrew and *then the issues related to the Griffon will be examined further.*

Pilots

General information and experience

The CH126 Griffon and CH124 Sea King pilots were very similar in terms of basic physical characteristics and experience, although the Sea King pilots did have a significantly higher number of years on their airframe compared to the Griffon pilots. This difference was not noted in the number of flying hours accrued on the airframe, however. As one would expect there was a wide gulf between the two communities in terms of NVG experience and use.

Considering the characteristics and experience of the two groups unrelated to NVG the two groups were quite well matched. This similarity is very useful for the remainder of the analysis as it tends to suggest that any differences noted later in the study would be due to the differences between the airframes and associated equipment and procedures as opposed to general characteristics of the groups surveyed. However, the much smaller number of Sea King pilots who responded to the survey does influence the reliability of statistical tests throughout the comparison.

Neck pain in pilots

It is very clear from Table 2 that a far greater proportion of Griffon pilots felt that they had experienced neck pain in relation to flying than the Sea King pilots. The statistical analysis of this difference revealed a very strong effect. Coupled with the similarities noted between the two groups of pilots earlier, this would seem to indicate that there are some significant differences between the two airframes in terms of whatever factors are causing neck pain. The vast difference in NVG use would tend to support the notion that NVG use could be at least partially responsible for the increased incidence of flight-related neck pain in the Griffon pilots.

It is interesting to note that over 20% of Griffon pilots who complained of neck pain related to flight felt that it was associated with their instructor status (note that not all of those were current instructors). There were a total of 39 Griffon pilots who identified themselves as current instructors, of whom 34 (i.e., 87.2%) indicated neck pain related to flight. Of those 34 a total of 18 (i.e., 52.9%) indicated that instructor status was associated with their neck pain. Conversely those respondents that were not current instructors would have accounted for 99 respondents, with 78 (i.e., 78.8%) indicating neck pain related to flight and six (i.e., 7.7%) of those 78 indicating that the pain was associated with instructor status. The proportion of current instructors indicating that they had experienced neck pain related to flight was not

significantly higher than the non-instructors. Without knowing how many of those pilots who were not current instructors had been instructors at some point it is impossible to compare current and past instructors in terms of rates of flight-related neck pain. Regardless it is interesting to note that over half of the current instructors with flight-related neck pain felt it was associated with their pain.

The Griffon pilots who indicated that infrequent flying status was associated with their neck pain (no Sea King pilots felt that way) may have been experiencing their pain as a result of their bodies readapting to the rigours of supporting the additional head supported mass of a helmet and potentially NVGs. Once the musculature of the neck had adapted sufficiently to support the associated loads the pain would diminish and the body would stay adapted and no pain would occur. Following an extended period without flying, the musculoskeletal adaptations could have diminished to the point where re-adaptation would have to occur. Given the small Sea King sample size the lack of a similar finding in that community does not necessarily imply that the effect does not occur there. However, one would expect the effect to be more pronounced if the loads on the head were greater such as is the case with NVGs.

Neck pain during flight

When initially comparing the proportion of pilots who had experienced neck pain during flight in Table 4 the responses were limited only to those who had indicated flight-related neck pain. In this way the comparison was looking only for differences in the manifestation of neck pain between those in the two groups with flight-related neck pain.

When all respondents are included as in Table 5 the results become much different, now indicating only what proportion of (all of) the pilots experienced neck pain during flight. As one would expect, the result is similar to the earlier comparison of the two groups in terms of general flight-related neck pain.

Regarding the number of episodes of neck pain experienced during flight there were no significant differences between the two groups of pilots. It is disturbing to note that close to 40% of the Griffon pilots and close to 35% of Sea King pilots who had experienced neck pain during flight had experienced more than 10 episodes. This would seem to indicate that the pain was becoming chronic in at least a reasonable portion of the pilots surveyed.

Due to the sizeable number of non-responses regarding the factors associated with neck pain during flight it was not possible to perform a reliable statistical analysis. Regardless, it certainly appears that the most common factor for the Griffon pilots was normal G flight with NVGs while the second most common factor was moderate G flight with NVGs. Flight without NVGs did not appear to be as great a concern to the Griffon pilots. Conversely, the Sea King pilots seemed to have the most neck pain during flight at low G without NVGs, followed by moderate G without NVGs. Since it is impossible to determine how many of the Sea King pilots never experienced low or moderate G flight with NVGs the fairly low number who indicated low G with NVGs as a factor may or may not be due to inexperience with that condition.

Neck pain after flight

As with the analysis of neck pain during flight, the proportion of pilots in the two groups who experienced neck pain after flight was not significantly different when only those who had indicated flight-related neck pain were compared.

Similarly, when all respondents were incorporated into the analysis the Griffon pilots had a significantly higher proportion of experiences of neck pain after flight. Again, this follows from the results of the question regarding flight-related neck pain in general.

Examining the number of episodes of neck pain experienced after flight there was also no significant difference between the two groups of pilots. The proportion of pilots indicating that their neck pain after flight had occurred over 10 times was quite high: almost 45% for Griffon pilots and over 55% for Sea King pilots. As with the number that had experienced such frequent episodes during flight this result would appear to indicate the a fair proportion of this experiencing pain after flight are in fact experiencing chronic pain.

Once again the analysis of factors associated with the neck pain was not possible due to response difficulties. The general trend is the same as the one noted in the case of neck pain during flight. Low G flight with NVGs was the most common factor for Griffon pilots, followed by moderate G flight with NVGs. Sea King pilots again indicated that low G flight without NVGs was the leading factor followed by moderate G flight without NVGs. Without a reliable assessment of how many Sea King pilots had experienced low or moderate G flight with NVGs the response to that question cannot be adequately gauged.

Severity and persistence of pain

The were no statistically significant differences between the two groups of pilots in terms of both the severity and persistence of neck pain, suggesting that the two groups of pilots are indeed experiencing the same type of injury causing mechanism.

Regarding severity of pain, it is disturbing to note that over 15% of Griffon and close to 25% of Sea King pilots who responded to the question felt that their worst episode of neck pain **during** flight was severe or incapacitating. The severe rating indicates that the pain disrupted the ability to perform normal duties while the incapacitating rating indicates the pain rendered the respondent unable to perform normal duties. From a flight safety perspective this is a very alarming finding. If the number who indicated severe or incapacitating pain during flight is compared to the number of respondents, the result is that 10.9% of Griffon and 8.6% of Sea King pilots surveyed indicated that in at least one case their ability to perform their normal flying duties was disrupted or completely compromised.

Duration of the pain experienced by the pilots is also a cause for concern. The large proportion of Griffon pilots (close to 50%) and Sea King pilots (over 50%) who experienced a worst episode of pain lasting in excess of one full day (and in many

cases in excess of four full days) is disconcerting in terms of flight safety as well as quality of life. For the average experience of neck pain 9.5% of Griffon pilots who responded to the question (or 7.2% of all surveyed) indicated that the pain lasted for over four full days. Presumably there have been instances where pilots still experiencing neck pain from a previous flight have flown during the duration of that pain - a possible risk to flight safety. Further, the implications to quality of life that days of pain can have are difficult to truly comprehend without a thorough understanding of the limitations it can impose on daily life.

Treatment

Despite the marked findings in the previous sections the number of pilots who sought medical treatment for their pain is surprising. Well less than half of the Griffon pilots who responded to the question regarding whether they had sough treatment indicated that they had. The proportion of Sea King pilots who had done so was even lower (although the difference was not statistically different the small number of Sea King respondents may be masking a difference between the groups).

It is well known that the majority of pilots are uncomfortable with at best, and often suspicious of, medical staff. Fear of grounding was mentioned in a few surveys and even more so in conversation with the pilots. Although few committed this to paper, there appears to be a belief amongst the pilots that medical staff either provide band-aid solutions (i.e., anti inflammatory medications, short rest periods) or grounding and generally seem unwilling or unable to spend the time thoroughly diagnosing or treating the problem. In fairness to the medical staff these opinions were anecdotal and the persons expressing them were clearly frustrated and therefore do not necessarily represent the most fair and objective assessment of medical support.

Examining the sources of treatment that the Griffon and Sea King pilots sought, it is clear that the military doctor was very frequently sought for medical care as one would expect (although a few pilots appeared to prefer a civilian doctor for assessment). The relatively high numbers of pilots who also sought therapeutic treatments (i.e., physiotherapy, chiropractic treatment and massage therapy) would seem to indicate that there were musculoskeletal issues involved in their neck pain.

When questioned about the treatment they received 25% of the Griffon pilots indicated that they did not receive treatment (all three Sea King pilots indicated that they had received treatment but the small number could easily mask a statistical difference). Unfortunately, it is difficult to interpret what precisely this means as some respondents clearly felt that although they did receive treatment it was only a partial solution and therefore not sufficient in their opinion whereas others may have felt the same way but still indicated that they received treatment. Furthermore, it is unreasonable to expect that all persons receiving medical treatment will be completely satisfied with the outcome even if exemplary medical care is provided. Regardless, the large proportion of Griffon pilots who felt they did not receive treatment would seem to be cause for some concern.

Given that approximately 15% of both Griffon and Sea King pilots (who responded to the question) indicated that they had been grounded as a result of flight related neck pain, the flight safety implications of neck pain would seem to be a fairly significant concern.

Comments

Reviewing the comments made by Griffon pilots in the survey five stood out as quite common (i.e., more than 10 percent of total respondents made the comment). The most common comment for the Griffon pilots regarded the action of looking down to operate or view the CDU, centre console or even a map. This comment was often associated with NVG but not all respondents were clear as to whether or not this was an issue without NVG. The forward (and sometimes sideways) flexion of the neck to view or use the CDU or centre console, or to read a map was considered the leading cause of neck pain in the Griffon pilots. There is no doubt that the placement of the CDU and centre console controls is poor ergonomic design, however, once the head is loaded with a flight helmet, NVGs and counterweight the situation becomes significantly worse. The level of flexion and rotation required to access the CDU appears to approach the limits of the neck, causing an increased loading on the soft and hard tissues that is only exacerbated by the addition of the flight helmet, NVGs and counterweight. Only one Sea King pilot made a similar comment, which implies that either the cockpit layout of the Griffon or the use of NVGs, or both, cause the Griffon pilots to have difficulty with the forward flexion of the neck required for the tasks described.

The second and fifth most frequent comments made by Griffon pilots regarded extended flying hours in a single day or night and concentrations of flying days in succession, respectively. These situations would offer those pilots little time to recuperate after their flight and would seem to indicate that there is some tolerable limit to flying duration, frequency and operational tempo that, when exceeded, is believed by the pilots to cause or contribute to neck pain. Proportionately fewer Sea King pilots indicated that these issues of flying hours per day and operational tempo were of concern in the context of neck pain. This may be because of differing training, differing flight and aircraft parameters, differing workup and operational schedules, or it may be due to the fact that Sea King pilots do not perform their flying duties with NVGs as the Griffon pilots often do.

The third most frequent comment for Griffon pilots indicated that the generally poor postures caused by cockpit ergonomics and task requirements contributed to their neck pain. Roughly the same proportion of Sea King pilots indicated the same tendency for pain due to the poor cockpit ergonomics and difficult task requirements required in their duties. The similarities in the proportion of comments made would seem to indicate that the generally poor postures required of the pilots are common across both rotary-wing platforms.

The fourth most frequent comment made by the Griffon pilots was that both continuous head movements due to scanning as well as static neck postures required in hovering and clearances were a factor in their neck pain. Since a proportionally greater number of Griffon pilots made these comments it would seem that either the Sea King pilots are not required to perform as many of these types of continuous head movements or static neck postures, or that the additional load of NVG is a factor here that was not explicitly mentioned.

A greater proportion of Sea King pilots indicated that they experienced back pain associated with flight than did Griffon pilots. Given the small number of Sea King pilots who responded to the survey the difference may not be significant. Anecdotally, a number of Sea King pilots indicated that back pain is endemic in the Sea King pilot community although this was note borne out in the comments on the questionnaires. Regardless of how common back pain is, the presence of back pain does point out that there are other pain and potentially injury mechanisms occurring in the pilots of both airframes.

Vibration and rapid head movement were mentioned in the comments of a relatively small number of Griffon pilots. Therefore it is presumed that the vibration of the airframe is not a significant factor in the neck pain experienced by the pilots. Regarding rapid head movement, it seems most likely that the pilots avoid making rapid movements of the head as doing so would seem very likely to lead to pain or injury.

Relatively few Griffon pilots commented on the weight of the kit being supported by the neck (i.e., helmet and NVGs), which was somewhat unexpected. Lively discussion about the weight of the NVGs and counterweight was very common in talking with the aircrew after the questionnaires were completed, therefore it may be that the nature of the questionnaire (being very specific about NVGs and their relation to neck pain) lead the respondents to assume that some issues (like the weight of the kit) were implied in other areas of the questionnaire or simply universally understood.

Other aircrew

General information and experience

Comparing the CH146 Griffon and CH124 Sea King other aircrew there were no significant differences between the two groups in terms of gender, height, weight, total flying hours and flying hours on their current airframe. There were differences in terms of age (with the Griffon FEs being older) and number of years flying and number of years flying on their current airframe (the Sea King other aircrew had more years experience in both cases). In terms of NVG experience, once again the Griffon crew demonstrated far more experience in terms of proportion who had used NVGs as well as total NVG hours and NVG hours in the last 28 days. Compared to the Sea King pilots a much higher proportion of the Sea King other aircrew had used NVGs.

The two other aircrew groups were not as well matched as the pilots, but still were quite similar. The similarities between the groups tends again to suggest that any differences noted later in the study would be due to the differences between the airframes and associated equipment and procedures as opposed to general characteristics of the groups surveyed. It is worth mentioning that the duties of the Griffon's FE do not match as well with those of the Sea King's TACCO and AESOP as the former airframe is a tactical helicopter while the latter is an antisubmarine platform. As a result, it is impossible to control for the impact that the differences between the duties of the two airframes will have on the results of the respondents.

Neck pain in other aircrew

The higher proportion of Griffon FEs with neck pain related to flying would seem to indicate some significant differences in the way that the two groups operate. As with the pilots, the differences in NVG experience supports the theory that the FEs increased NVG usage compared to the Sea King other aircrew is responsible for the increased rate of neck pain. However, it is not possible to discount other potential causes for the difference in injuries such as the specifics of the duties and postures associated with the different crew positions and airframes.

It is interesting to note that the proportion of Griffon FEs who indicated they had experienced neck pain unrelated to flying was lower than the Sea King other aircrew. It is possible that the issue of neck pain has become so well known in the Griffon community that the FEs are prone to assume that most neck pain is due to flying even though that may not be the case.

Regarding the responses to circumstances associated with the flight-related neck pain there were no significant differences noted between the Griffon and Sea King groups. It is interesting to note that in both groups there were small numbers who felt that instructor status or infrequent flying duties contributed to the flight-related neck pain. As instructors are required not only to supervise the student they are training/assessing but also to perform as a backup to the student a number of respondents reported that they frequently perform a greater proportion of head and neck movements than normal flight would require. This increased activity could be responsible for the perceived association between neck pain and instructor status. Interestingly, all six of the Griffon FEs who indicated that instructor status was a factor in their neck pain were current instructors.

The implication of infrequent flying duties being associated with flight-related neck pain again tends to imply that there is some sort of musculoskeletal adaptation that occurs in at least a proportion of the aircrew during regular flying duties. When duties cease for a period of time this adaptation would then diminish and the body would then need to be trained to re-acquire the specific adaptation to the tasks again.

Neck pain during flight

When initially comparing only those other aircrew who had experienced flight-related neck pain there was no significant difference in the proportion who had experienced neck pain during flight. This would seem to indicate that at least a portion of those that have experienced flight-related neck pain regardless of aircraft are generally experiencing the same sort of mechanism of pain such that it is occurring during flight. The similar patterns of the number of incidents of neck pain experienced by the two different groups would seem to support this notion that there is a common mechanism at play. This would also tend to imply that the duties performed by both groups are similar enough to cause similar types of injuries.

When the analysis includes all respondents it becomes clear that a much larger proportion of Griffon FEs experiences neck pain during flight. This would seem to support the theory that there is something about the FE role in the Griffon that causes

a significant increase in neck pain during flight. The vastly differing levels of NVG usage between the two groups is a plausible cause for this difference (although the differing duties of the FE cannot be discounted). This hypothesis is supported by the larger proportion of Griffon FEs who indicated that NVG use under low and moderate G was associated with their neck pain whereas the Sea King other aircrew emphasized low G flight without NVGs as the major factor in their pain although they did indicate NVG use at low G was a factor in some cases.

The discussion in the preceding two paragraphs may seem contradictory - the former indicating that a similar mechanism is causing the neck pain, while the latter indicates that NVG use (and perhaps differing duties) is responsible for the increased proportion of neck pain during flight in the Griffon FE group. Both concepts may be correct if the underlying assumption is that head-mounted load coupled with the rigours of the flying duties involved is to blame for the neck pain. If that is the case then the increased weight associated with NVG would presumably increase the incidence rate (as is the case for the FEs) but would still follow the same general mechanism for at least some aircrew.

It is interesting to note that there was no significant difference in the comparison of the number of episodes of neck strain encountered. The fact that almost half of both groups of other aircrew experienced at least 10 episodes of neck pain again implies that at least a portion of the respondents are likely experiencing chronic injuries.

Neck pain after flight

Unlike the previous section, the analysis of neck pain after flight indicated that regardless of whether just those respondents who had indicated flight-related neck pain or all respondents were used, the Griffon FEs had a greater proportion of experiences of neck pain after flight. In the former case, where we consider only those who had indicated flight-related neck pain, the proportion of FEs who had experienced pain after flight was almost 100%. In comparison, the proportion of Sea King other aircrew who indicated neck pain after flight was 66.7%. This supports the notion that there may be a similar pain mechanism between the two groups, although it is clear that the Griffon FEs are experiencing a far greater response to the mechanism.

When considering all respondents the proportions who experienced pain after flight change somewhat: the Griffon FEs still have a higher proportion than the Sea King other aircrew, but distressingly, close to 83% of the Griffon FEs who responded to the survey indicated at least one experience of neck pain after flight.

The experience of pain after flight indicates that overexertion had occurred and potentially that some form of soft tissue damage as well. Considering that even larger proportions of respondents (compared to pain during flight) had indicated a minimum of 10 episodes of pain after flight, the potential for long term cumulative damage to the structures of the neck would seem high for a sizeable proportion of the respondents.

As before, the Griffon FEs indicated that low and moderate G flight with NVGs were the leading factors associated with their neck pain after flight while the Sea King other aircrew emphasized low G flight without NVGs but did to a lesser extent indicate that low G with NVGs and moderate G without NVGs were also factors.

Taking all of the above into account it is clear that the Griffon FEs experience more neck pain after flight than the Sea King other aircrew and that this difference appears to be at least in part due to the much more frequent use of NVGs by the FEs, although again it is impossible to discount the differing duties performed aboard the Griffon.

Severity and persistence of pain

As with the pilots, the absence of a statistically significant difference between the two groups of other aircrew in terms of both the severity and persistence of neck pain reinforces the notion that the two groups are experiencing the same general type of injury causing mechanism.

The worst experiences of pain during flight for the other aircrew were generally limited to the mild and moderate ratings although a modest proportion of the Griffon (12.5%) and Sea King (10.5%) respondents indicated severe experiences and only a single FE indicated an incapacitating experience. While an improvement compared to the pilot groups, this level of disruption to the ability to perform normal duties is still a valid flight safety concern.

The worst pain experienced after flight was severe or incapacitating for over one quarter of the Griffon FEs and 40% of the Sea King other aircrew who responded. Average pain during and after flight was largely of the mild and moderate variety.

The duration of the worst episode of pain after flight was in excess of four days for 16.3% of Griffon FEs and 5% of Sea King other aircrew. Similar proportions (10.6% and 5%, respectively) experienced the same four day duration of pain for the average experience of neck pain after flight.

The severities and durations of neck pain experienced by the other aircrew should be alarming not only from a flight safety standpoint, but also from a quality of life standpoint. While mild and moderate ratings of pain do not seem particularly troublesome, it is important to consider that there may well be aircrew who are experiencing these levels of pain on an often recurring basis or experiencing them for extended periods of time.

Treatment

As with the pilots, the number of other aircrew who sought medical treatment was not impressive. Less than half of the Griffon FEs and only one quarter of the Sea King other aircrew sought treatment (of those that responded to the question).

Comments made in the questionnaires and verbally to the author indicate that the other aircrew exhibit the same general distrust of the medical staff as the pilots did. Similar to the pilots, the other aircrew reported tales of band-aid solutions and diagnoses of pain being simply due to ageing without any significant examination. Once again it is imperative to state that these were opinions of aircrew who were obviously upset and may not have been presenting the incidents in a clear and objective manner.

The majority of other aircrew in both groups who indicated a source of treatment used a military doctor while a handful of Griffon FEs sought the care of a civilian doctors (presumably due to concerns of grounding or perceived lack of adequate care). It is unclear why a smaller proportion of other aircrew would have sought or been prescribed therapeutic treatments (i.e., physiotherapy, chiropractic treatment and to a lesser extent massage therapy) than the pilots.

Regarding treatment, almost one third of Griffon FEs and 20% of Sea King other aircrew indicated that they had not received treatment. As with the pilots, it is clear that some other aircrew felt that whatever treatment they did receive was inadequate and therefore amounted to no treatment while may have felt the same way but still indicated that they received treatment.

Compared to the pilots, a higher proportion of the other aircrew indicated that they had been grounded as a result of flight related neck pain. Over half of Griffon FEs and over a quarter of Sea King TACCOs and AESOPs indicated such grounding. This sizeable proportion would seem to indicate that the neck pain has a tremendous impact on the safe conduct of operations, precluding the other aircrew from safely performing their duties.

Comments

Examining the comments made by the Griffon FEs eight stood out as fairly common (i.e., more than 10 percent of total respondents made the comment). The most frequent comment made by the FEs and the other aircrew in the Sea King was regarding operations with the head out of the side (Griffon) or rear (Sea King) door, such as performing slopes, clearances, hoisting or slinging. Such activities often require the other aircrew to position themselves with a large portion of the torso extended past the floor of the aircraft (into the airflow and rotor downwash), supporting the torso and head with the muscles of the back and neck respectively. Additionally, the other aircrew are sometimes required to extend or look up at the rotor arc to ensure clearance which is a particularly difficult position to maintain. The arduous nature of these types of duties on board the Griffon is well documented in the ergonomic assessment conducted by Wierstra (2001). Clearly the requirement to flex, extend and rotate the unsupported neck with the additional weight of a flight helmet, NVGs and counterweight places significantly greater loads on the hard and soft tissues of the neck than one would normally experience in normal daily activities. The lower proportion of Sea King other aircrew who indicated the same issue would seem to support the notion that the duties of the Griffon FEs are more physically demanding, at least in terms of those performed while hanging portions of the body out of the aircraft.

The second and third most common comments made by the FEs involved extended flying hours in a single day or night and high operational tempo, causing concentrations of flying days in succession such as during workups or deployments, respectively. As before, this increase in flying time without adequate rest between missions would seem to indicate that there is a limit to flying duration, frequency and operational tempo that when exceeded is perceived to cause or contribute to neck pain. Fewer Sea King other aircrew made the same types of comments as their Griffon counterparts. As with the pilots this may be because of differing training, workup and operational schedules, differences in NVG use between the aircraft or differences in the physical demands of the duties performed.

The weight of the kit supported by the neck (i.e., flight helmet, NVGs and counterweight) was the fourth most frequent comment that FEs associated with neck pain. A smaller proportion of Sea King other aircrew made the same comment, and both groups of other aircrew made the comment more frequently than the pilots of the same airframe. Given the particularly difficult nature of some of the out-of-door postures required of the other aircrew it is quite understandable that the weight of any kit supported by the neck (and also the back as the torso is cantilevered outside the aircraft) would be of particular concern to the other aircrew.

The same number of Griffon FEs commented on instructor status and rapid or continuous head movements as being associated with their neck pain. Those that felt that instructor status was associated with their pain indicated that they were required to perform much more head movements as an instructor than during normal flight. Given the additional loads of the NVGs and counterweight it also makes sense that at least a portion of the Griffon FEs felt that rapid or continuous head movements were associated with their pain. Almost no Sea King other aircrew felt the same way about instructor status and none felt that rapid or continuous head movements were associated with their neck pain. This would seem to confirm that there is something unique about the FE duties on the Griffon (compared to those in the rear of the Sea King) that causes the rapid or continuous head movements to exert a greater pain-causing impact. Presumably the cause is the additional weight of NVGs and counterweight and the differences in the duties between the two airframes.

Approximately equal proportions of Griffon FEs and Sea King other aircrew commented on the poor postures caused by crewstation ergonomics and task requirements as contributing to their neck pain. Ideally crewstations are designed with the anthropometric limitations of the users in mind but in practical terms the ergonomics of crewstations are often impacted by other engineering constraints. The result is the common condition whereby the users are forced to adapt to the system by utilizing awkward postures or uncomfortable seating or operating positions for example. Clearly there are a number of Griffon FEs and Sea King other aircrew with ergonomic issues in their respective airframes. Without knowing the details of the specific ergonomic issues it is impossible to determine how those issues directly interact with or cause neck pain.

Finally, approximately 10% of Griffon FEs (compared to only 2% of Sea King other aircrew) indicated that they were also experiencing back pain as a result of flight duties. Given that back pain was not the focus of the questionnaire it would seem reasonable to expect that an even greater proportion of Griffon FEs have experienced back pain as some respondents would not necessarily have thought to comment on back pain when completing the survey. Furthermore, a number of Griffon FEs approached the author after completing the

questionnaire to inquire as to whether or not a similar study was planned to investigate back pain. The interest expressed coupled with the ergonomic assessment conducted by Wierstra leads the author to conclude that back pain may be as significant an issue in the FE community as neck pain is. It is interesting, however, to note that the Sea King other aircrew do not seem to experience the same rate of back pain as the Griffon FEs. Presumably this is due to the differing nature of the duties on the Sea King or perhaps the additional weight of the NVGs and counterweight have a biomechanical impact further down the spine than just the neck.

Conclusions

Pilots

General information and experience

Both groups of pilots were fairly well matched in terms of basic physical characteristics and flying experience, but differed greatly in terms of experience with NVGs. The much smaller number of Sea King respondents may have influenced the reliability of some of the statistical findings.

Neck pain in pilots

Significantly more Griffon pilots reported neck pain related to flying compared to the Sea King pilots. Given the relative similarities between the two groups of respondents (excepting NVG experience) and the similar flight duties in both airframes, NVG use appears to be the leading factor in the increased rate of neck pain related to flying in the Griffon pilots.

Instructor status, with its requirements for greater supervision and scanning, appears to increase the likelihood of neck pain in Griffon pilots.

At least a portion of Griffon pilots appear to require some sort of musculoskeletal adaptation to the use of NVGs which degrades when NVGs are no longer used.

Neck pain during flight

The same proportion of Griffon and Sea King pilots reported experiences of neck pain during flight (of those who experienced flight-related neck pain). Significantly more Griffon pilots overall experienced neck pain during flight.

Sizeable numbers of Griffon and Sea King pilots who experienced neck pain during flight are experiencing sufficient numbers of episodes to suggest that the pain is chronic (not acute) and directly related to flight.

Griffon pilots identified low and moderate G flight with NVGs as the leading factors in their neck pain during flight whereas Sea King pilots identified low and moderate G flight without NVGs as the leading factors in their neck pain during flight.

Combining all the above findings it is clear then that the Griffon pilot group had a much higher incidence rate of neck pain during flight overall, but the mechanism causing the neck pain appears to be similar enough between the two groups so as to manifest in roughly the same manner (note the similar proportion of those experiencing neck pain during flight when considering only those who had indicated flight-related neck pain and the similar number of episodes of neck pain encountered).

This would seem to indicate that the Griffon pilots are being exposed to a stronger cause factor or factors, which caused the same type of injury as the Sea King pilots but was somehow present in a greater proportion of the respondents. The vastly greater NVG use associated with Griffon piloting is suggested as the leading cause factor. The large proportion of Griffon pilots (almost two thirds) who indicated that low G flight with NVGs was a factor in their neck pain during flight would seem to provide strong support for this theory.

Neck pain after flight

The same proportion of Griffon and Sea King pilots who experienced flight-related neck pain reported experiences of neck pain after flight, however significantly more Griffon pilots overall experienced neck pain after flight.

A large proportion of Griffon and Sea King pilots who experience neck pain after flight are experiencing sufficient numbers of episodes to suggest that the pain is chronic and not acute.

Once again Griffon pilots identified low and moderate G flight with NVGs as the leading factors in their neck pain after flight while Sea King pilots identified low and moderate G flight without NVGs as the leading factors in their neck pain after flight.

The combination of these three findings again supports the notion that the mechanism of neck pain in the two groups is similar enough, but it is far more common in the Griffon pilots overall. Once again the strong response from Griffon pilots that NVG use in low G flight was a factor leads to the theory that the use of the NVGs in flight is an important factor in the increased rate of neck pain experienced by the Griffon pilots although the general mechanism of injury appears to be similar enough between the two groups of pilots.

Severity and persistence of pain

The lack of any statistically significant difference between the two groups of pilots in terms of both the severity and persistence of neck pain further reinforces the notion that the two groups of pilots are experiencing the same type of injury causing mechanism.

Approximately 10% of the pilots surveyed indicated that they had experienced a worst episode of neck pain during flight that was severe or incapacitating. This means that one in ten pilots, at some point during flight, had their ability to safely pilot the aircraft disrupted or completely removed. It is unlikely that this level of risk is acceptable in the aviation environment.

Some pilots indicated long lasting pain as a result of flying, implying that quality of life was being affected by their condition.

Treatment

The majority of pilots who indicated some form of pain had not sought medical treatment. Distrust of, and perhaps dissatisfaction with, the medical care provided by the CF appear to be the causes.

Given that many pilots experiencing pain do not seek medical treatment, the 15% of pilots who were grounded at some point due to neck pain is probably lower than the number who should have been. There are almost certainly pilots flying on any given day that should not be doing so as a result of neck pain or injury.

Comments

Forward flexion (and rotation) of the neck, such as required to operate the CDU or read a map, was the single most common comment made by Griffon pilots. Clearly the location and ergonomics of the CDU are poor. When coupled with the additional weight of NVGs and counterweight the situation becomes even worse. Given the remarkably high number of Griffon pilots who commented on the CDU, and considering that forward flexion induces high bending moments, it would seem that the location of the CDU is the main cause factor for neck pain in Griffon pilots, especially when NVGs are in use.

Extended missions or concentrations of flying on successive days and weeks seem to exceed the limitations of some pilots, particularly Griffon pilots, leading to neck pain. NVG use may increase the likelihood that an extension of a flight or multiple sorties in a relatively short time span will cause pain.

In general there appears to be a fair portion of pilots who have a number of ergonomic issues associated with piloting helicopters.

Head movement and maintaining static postures with NVGs and counterweight attached to the helmet is suggested as the reason that more Griffon pilots indicated that there was an association between neck pain and those movements and postures.

Just under 10% of pilots indicated that they experience back pain as a result of flying. There may therefore be even more health concerns to investigate in the rotary wing environment than just neck pain.

Other aircrew

General information and experience

Although the two groups of other aircrew were generally well matched in terms of physical attributes and experience there were significant differences in terms of age and number of years on the current airframe. The Griffon FEs were also significantly more experienced with

NVG than the Sea King other aircrew although the Sea King other aircrew were at less of a deficit compared to the Sea King pilots (in terms of NVG experience). Furthermore, the duties of the groups differ enough that it is difficult to ignore the impact that these differences may have on the incidence and severity of neck pain.

Neck pain in other aircrew

Griffon FEs indicated higher rates of neck pain related to flying. Presumably this is due to their increased NVG usage and differing duties performed compared to the Sea King other aircrew.

The increased duty requirements associated with instructor status appears to be a factor in the neck pain experienced by some Griffon FEs and to a lesser extent, some Sea King other aircrew.

A portion of both groups of other aircrew appear to demonstrate some sort of musculoskeletal adaptation to the rigours of their flight duties, which diminishes during periods of no flying.

Neck pain during flight

As with the pilots, the same proportion of those Griffon FEs and Sea King other aircrew who experienced flight-related neck pain reported experiences of neck pain during flight while significantly more Griffon FEs overall experienced neck pain during flight.

Almost half of Griffon FEs and Sea King other aircrew who experienced neck pain during flight experienced sufficient numbers of episodes to suggest that the pain is chronic in nature and related to flying.

Griffon FEs identified low and moderate G flight with NVGs as the leading factors in their neck pain during flight. Conversely, Sea King other aircrew identified low G flight without NVGs as the leading factor in their neck pain during flight although some did indicate that NVG use at low G was a factor.

Taking the above into account it is suggested that the two groups of other aircrew are experiencing the same mechanism of neck pain but the effect is stronger in the Griffon FEs. The increased effect in the FEs is presumably due to the greater use of NVGs and the different tasks performed by the FEs compared to the Sea King other aircrew.

Neck pain after flight

Regardless of how the proportions are examined (i.e., either just those who had indicated flight-related neck pain, or all respondents) a greater proportion of Griffon FEs indicated experiences of neck pain after flight.

The prevalence of neck pain after flight would seem to indicate that overexertion of muscles is occurring during flight.

Almost two-thirds of Griffon FEs and three-quarters of Sea King other aircrew who experienced neck pain after flight experienced sufficient numbers of episodes to suggest that the pain is chronic in nature, and directly related to flying.

As before, Griffon FEs identified low and moderate G flight with NVGs as the leading factors in their neck pain during flight while Sea King other aircrew identified low and G flight without NVGs as the leading factor in their neck pain during flight. To a lesser extent some Sea King other aircrew did indicate that NVG use at low and moderate G was a factor in their pain after flight.

The greatly increased rate of neck pain after flight indicated by the Griffon FEs indicates that the nature of their flying operations are clearly more damaging than the Sea King other aircrew, although the same general mechanism appears to be at play in both groups. NVGs considered an important factor, as are the specific task requirements of the on FE.

Severity and persistence of pain

Further reinforcing the notion that the two groups are experiencing the same general type of injury causing mechanism is the finding that (as with the pilots) there was no statistically significant difference between the two groups of other aircrew in terms of both the severity and persistence of neck pain.

In some cases the severe and incapacitating levels of, and the sometimes long lasting effects of, the neck pain experienced by the other aircrew no doubt impact on quality of life.

Treatment

As with the pilots, the majority of other aircrew who indicated some form of pain had not sought medical treatment. Distrust of, and perhaps dissatisfaction with, the medical care provided by the CF again appear to be the cause.

The high proportion of Griffon FEs who had been grounded due to neck pain is a clear indication that their ability to conduct their duties is compromised by the pain they are experiencing. Given the reticence of the other aircrew to seek medical intervention it is presumed that some are flying when they should be grounded.

Comments

The greater proportion of Griffon FEs who indicated that out-of-door operations were a factor in their neck pain would seem to indicate that the FE duties are in fact more physically demanding than their Sea King counterparts.

Extended missions or high operational tempo exceed the limitations of a fair portion of Griffon FEs, leading to neck pain. NVG use and the difficult nature of the FE duties clearly create a physiological limit in some FEs that can be exceeded during extended missions or times of high operational tempo.

The difficult nature of out-of-door operations, especially those of the FEs, creates a situation where some other aircrew are particularly sensitive to the weight of kit that is supported on their heads.

Instructor status and rapid or continuous head movement appear to exacerbate neck pain in some Griffon FEs, presumably due to interactions with the duties and the weight of NVGs and counterweight.

Over 10% of other aircrew indicated that they are required to operate under conditions of poor posture as a result of the ergonomics of the airframe.

Back pain may be as significant an issue in the Griffon FE community as neck pain.

Recommendations

NVG use clearly contributes to neck pain in Griffon aircrew. Operations demand the use of NVGs, therefore it is impossible to discontinue their use. Commanders need to be made aware of the physiological limitations of their aircrew and the physical demands that NVG use implies so that they can be used safely and effectively.

For at least a portion of the Griffon aircrew, instructor status is a factor in their neck pain. Therefore instructors should be encouraged to assess their own limits in terms of flying hours, frequency and use of NVGs. An increase in the number of instructors or a lengthening of training courses to allow for reduced numbers of sorties per day or night may be necessary to accommodate the physiological limitations of the instructors. It is understood that NVG use in summer months is often reduced as the available periods of night flying are shorter than the winter. Attempts should be made to better distribute NVG flying hours throughout the year.

A portion of Griffon pilots and FEs as well as Sea King other aircrew indicated that discontinuity of flying was a factor in their neck pain. Therefore it is recommended that all aircrew maintain sufficient continuity of flying (both with and without NVGs) to ensure that they do not lose any musculoskeletal adaptations. Clearly this will vary on a personal basis, therefore individual aircrew will need to determine and advise their chain of command if they are experiencing difficulties associated with discontinuity of flying duties.

The instances of severe and incapacitating neck pain during flight represent a significant flight safety concern. Such pain may occur without warning and could conceivably result in an accident. It is therefore recommended that aircrew be educated to consider the implications of any minor pain or injury they may have becoming severe or incapacitating during a critical phase of flight.

The number of aircrew experiencing multiple episodes of neck pain and/or persistence of pain in excess of four days clearly presents operational and quality of life issues. Chronic pain can greatly impact the quality of life – the author has spoken with a small number of aircrew who now regret not taking earlier steps to investigate their neck pain as they now have chronic pain. Aircrew need to be made aware of the long term health and quality of life implications of pain and injuries they may be experiencing currently. The best way to do so is in consultation with CF medical staff with the acknowledgement and deference of command staff.

Aircrew are, in general, distrustful of the medical staff. This distrust translates into aircrew who are experiencing pain and injury not seeking the medical care of flight surgeons and other qualified medical staff. Clearly this is unacceptable, however there is not likely to be a simple solution to this problem. Aircrew must be made to understand that the medical staff are there to provide medical support and care in the best interest of the member and the CF. In some cases grounding of the aircrew as a safety measure will occur – something that aircrew must also come to accept is in the best interests of both themselves and any other aircrew they are flying with.

Whether or not there is a deficiency in the medical care being provided to the aircrew (and this report is in no position to imply that a deficiency exists) there is definitely a perception in the minds of a sizeable portion of the aircrew that such a deficiency exists. The CF Health Service should therefore take the initiative and use this issue as a means to develop a better relationship between the medical and aircrew communities. Aircrew in one Griffon unit indicated that they had encouraged their local flight surgeon to take part in a NVG mission. The flight surgeon had expressed that after the flight he better understood the scope of the neck pain issue. Therefore, it is also in the best interests of the units to ensure that the local flight surgeons are made to feel welcome and part of the flying organization so that they will be able to foster the types of relationships with aircrew that will support the flight safety aspects of aviation medicine.

One particular example of the gulf between the medical staff and some aircrew was the issue of access to MRI (magnetic resonance imaging) scans. MRI offers the advantage of being better at diagnosing soft tissue damage than the traditional X-ray and therefore may be an important diagnostic tool in the context of neck pain and injury. One aircrew spoke of experiences where they asked for an MRI to determine what damage if any was present in the structures of their neck, but were denied access to the procedure by the medical staff. Obviously this is only one side of the story, and presumably there was a sound medical basis for not performing the MRI, however, the aircrew concerned gave the impression that the concerns had not been taken seriously by the medical staff. He also implied that the cost of the test may have been a factor. Once again, this is only one side of the story, but it illustrates that the distance between medical staff and aircrew needs to be addressed if both groups are to be able to work together to ensure the common good.

The numbers of pilots and other aircrew who had been grounded as a result of neck pain reinforces the serious flight safety implications of neck pain. Aircrew must be encouraged to behave conservatively regarding flying while experiencing neck pain.

The location of the CDU in the Griffon is responsible for a number of episodes of neck pain and therefore should be addressed. It is recommended that an ergonomic assessment of the Griffon cockpit be conducted to determine what other issues may be present, especially during NVG operations.

The out-of-door duties of the Griffon FE are undoubtedly extremely physically demanding. It is doubtful that the tasks can be modified sufficiently or not conducted, therefore it is recommended that thorough medical care perhaps involving more frequent physical examinations or the involvement of physiotherapists be instituted so that any deterioration can be assessed and addressed early.

Aircrew differ in their ability to withstand the physical demands of their flight duties especially when missions are long, repeated multiple times in a day or night, or when operational tempo is high. Individual aircrew need to assess their own limits and be encouraged to indicate these limits to their chain of command so that individuals are not forced to operate beyond their physiological limits.

The weight of NVGs and counterweight are a significant physical burden. It does not appear that dramatic weight reductions in NVG technology are expected in the coming years.

therefore more research into the optimal way to integrate the additional load of NVGs into the helmet system is required.

A portion of the aircrew surveyed indicated general ergonomic deficiencies in both aircraft. Although the human body is remarkably adaptable, not all aircrew are able to adapt to the physical limitations of the aircraft. An ergonomic assessment of both aircraft with representative users performing representative tasks would uncover the ergonomic deficiencies. Once the deficiencies are determined they should be addressed.

In consideration of the comments made in the questionnaires and numerous requests for a similar study investigating back pain the author received while conducting this study it is recommended that a similar study be performed to assess the issue of back pain in the Griffon community. The ergonomic assessment of FE duties conducted by Capt Wierstra in 2001 recommended such a study, which to the knowledge of the author, has not been conducted to date.

More research into the underlying mechanisms of neck pain is required in order to determine what countermeasures may be appropriate and feasible. Without the proper background research any suggested form of prophylaxis could potentially cause as much damage as benefit (for example, the notion of strength training the neck could easily result in numerous training injuries and may not build appropriate musculoskeletal adaptations). This research should be conducted in league with allied efforts so that more resources may be leveraged in the work.

As there is currently an NVG omnibus project underway to integrate NVG in the all airframes in the CF inventory, there exists a short window of opportunity to commence a longitudinal study into the short and long term health effects of NVG use in aircrew of rotary wing, fixed wing and fighter aircraft. It is suggested that a comprehensive study be conducted that examines the current state of CF aircrew in terms of neck pain or injury and other physiological metrics that are expected to be affected by NVG use. The participants in the study should then be tracked and follow up assessments should be made on a continuing basis to determine what rates and types of pain or injuries are being experienced by the aircrew.

It is also recommended that future studies be conducted via personal interviews, as there were clear indications that in some cases questions were interpreted in a manner that did not necessarily reflect the aims of the study. Furthermore, it is expected that face to face interviews would allow members to provide more representative results as their responses need not be as highly regimented as they are on a paper based questionnaire.

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Annex A: English questionnaire

Section 1: Personal Information

1. Please fill in the blanks or check the boxes as appropriate:

Age: _____ years

Gender: Male: ☐ Female: ☐

Height: ___ feet _____ inches **OR** _____ cm

Weight: _____ lbs **OR** _____ kg

Squadron: _____

2. Please fill in the following table to indicate, on average, how often you have exercised over the last year and what form of exercise you have undertaken.

	Aerobic exercise (e.g., running, cycling)	Weight lifting	Specific neck exercises	Other (please specify below)
Every day	☐	☐	☐	☐
2-5 times per week	☐	☐	☐	☐
Once per week	☐	☐	☐	☐
1-3 times per month	☐	☐	☐	☐
Less than once per month	☐	☐	☐	☐
Never	☐	☐	☐	☐
	Specify other forms of exercise:			

3. In which year (e.g., 1999) did you begin your military flying career (i.e., received your wings)?

_____

4. What is your current aircrew position?

CH146 Griffon	Pilot: ☐	Flight Engineer: ☐	Other (specify below): ☐	
CH124 Sea King	Pilot: ☐	TACCO: ☐	AESOP: ☐	Other (specify below): ☐

Other:

5. Are you currently a military flying instructor?

Yes: ☐ No: ☐

If yes please specify type(s):

6. From your log book, what is your total number of flying hours to date?

Total hours to date: _____ • __

7. Please specify your experience in the **military rotary-wing** aircraft you have flown or crewed within the last **ten** years. Include the total number of years and the approximate number of hours logged in each (e.g., 2 years, 300 hours):

Aircraft type	Total years in aircraft	Total hours in aircraft	Aircraft type	Total years in aircraft	Total hours in aircraft
Griffon			Voyageur/Labrador		
Cormorant			Sea King		
Twin Huey			Jet Ranger/ Kiowa		
Other			Specify Aircraft		
Other			Specify Aircraft		

Section 2: Helmets and Night Vision Goggles

8. Please indicate which type of flying helmet you most commonly use:

SPH-5: ☐	HGU-56P: ☐

9. Have you ever used night vision goggles (NVGs)?

Yes: ☐ No: ☐

IF "NO" PLEASE GO TO SECTION 3 ON PAGE 5

10. From your log book, what is your total number of hours flying with NVGs to date and in the last 28 days?

Total NVG Hours: _____ • __ NVG hours last 28 days: _____ • __

11. How long do you typically wear NVGs during a night flight?

Average hours of NVG use per night flight: __ • __

12. For each NVG type you have used (e.g., AN/AVS-6, AN/AVS-9) please indicate:
- The aircraft flown while wearing that type of goggle
- The number of flight hours using that aircraft / goggle combination
- The date that combination was last flown
- Is additional counterbalance weight **usually** used?
- If so how much?

NVG Type	Aircraft	Flight Hours	Date Last Flown (month/yr)	Additional weight?		Additional weight (612g is standard)
				Yes:	No:	
AN/AVS-6		.	/	☐	☐	g
		.	/	☐	☐	g
AN/AVS-9		.	/	☐	☐	g
		.	/	☐	☐	g
AN/AVS-502		.	/	☐	☐	g
		.	/	☐	☐	g
Other (specify)		.	/	☐	☐	g
Other (specify)		.	/	☐	☐	g

Section 3: Neck Strain, Neck Pain or Neck Injury

The following questions should be answered with regard to your experiences of any neck related symptoms:

13. Have you ever experienced neck pain that was **unrelated** to flying?

Yes: ☐ No: ☐

If "Yes", please describe the cause and the symptoms experienced:

If you require more space please use the final blank page of this questionnaire

14. Have you ever experienced neck pain that was **related** to flying?

Yes: ☐ No: ☐

If "Yes", please describe the cause and the symptoms experienced:

If you require more space please use the final blank page of this questionnaire

IF "NO" PLEASE GO TO SECTION 4 ON PAGE 10

15. Please indicate if you think your neck pain was associated with any of the following circumstances:

Student pilot status: ☐	Instructor pilot status: ☐	Infrequent flying duties: ☐
Recent illness/injury: ☐	Particular mission type (please describe) : ☐	

Please provide a brief explanation of the circumstances(i.e., flight regime, body position, seating position, etc.):

If you require more space please use the final blank page of this questionnaire

16. Have you ever experienced neck pain **during** flight?

Yes: ☐ No: ☐

IF "NO" PLEASE GO TO QUESTION 19 ON PAGE 7

17. Please indicate the total number of episodes of neck pain you have experienced **during** flight:

1 episode: ☐	2-3 episodes: ☐	4-6 episodes: ☐
7-10 episodes: ☐	More than 10 episodes: ☐	

18. Which of the following factors was associated with your neck pain **during** flight?

	Yes	No	Not Applicable
Low G (normal flight) **without** NVGs:	☐	☐	☐
Low G (normal flight) **with** NVGs:	☐	☐	☐
Moderate G (2G)(manoeuvring) **without** NVGs:	☐	☐	☐
Moderate G (2G)(manoeuvring) **with** NVGs:	☐	☐	☐
Other (please specify):	☐	☐	☐

19. Have you ever experienced neck pain **after** flight?

Yes: ☐ No: ☐

IF "NO" PLEASE GO TO QUESTION 22 ON THIS PAGE

20. Please indicate the total number of episodes of neck pain you have experienced **after** flight:

1 episode: ☐	2-3 episodes: ☐	4-6 episodes: ☐
7-10 episodes: ☐	More than 10 episodes: ☐	

21. Which of the following factors was associated with your neck pain **after** flight?

	Yes	No	Not Applicable
Low G (normal flight) **without** NVGs:	☐	☐	☐
Low G (normal flight) **with** NVGs:	☐	☐	☐
Moderate G (2G)(manoeuvring) **without** NVGs:	☐	☐	☐
Moderate G (2G)(manoeuvring) **with** NVGs:	☐	☐	☐
Other (please specify):	☐	☐	☐

Using the following scale, please answer the questions below:

Mild (noticeable but did not interfere with normal duties)
Moderate (difficult to concentrate on normal duties)
Severe (disrupted ability to perform normal duties)
Incapacitating (unable to perform normal duties)

22. Please indicate the severity of neck pain, for the **worst** episode of pain experienced:

	Mild	Moderate	Severe	Incapacitating	Not Applicable
During flight:	☐	☐	☐	☐	☐
After flight:	☐	☐	☐	☐	☐

23. If you commonly experience neck pain, please indicate an **average** severity of pain experienced:

	Mild	Moderate	Severe	Incapacitating	Not Applicable
During flight:	☐	☐	☐	☐	☐
After flight:	☐	☐	☐	☐	☐

24. How long did the symptoms persist for the **worst** episode of neck pain?

During flight only: ☐	Less than 2 hrs after flight: ☐
2-11 hours after flight: ☐	12-24 hours after flight: ☐
1-4 days after flight: ☐	More than 4 days after flight: ☐

25. How long do the symptoms usually persist for the **average** episode of neck pain?

During flight only: ☐	Less than 2 hrs after flight: ☐
2-11 hours after flight: ☐	12-24 hours after flight: ☐
1-4 days after flight: ☐	More than 4 days after flight: ☐

26. Have you ever sought treatment from a doctor or other consultant (e.g. physical therapist) for any occurrence of flight related neck pain?

Yes: ☐ No: ☐

IF "NO" PLEASE GO TO QUESTION 29 ON PAGE 9

27. Who was the treatment sought from, and how many times:

	Number of times:		Number of times:
Military doctor: ☐		Chiropractor: ☐	
Civilian doctor: ☐		Massage Therapist: ☐	
Med A/Physician's assistant: ☐		Acupuncturist: ☐	
Physical therapist: ☐		Other (please specify):	

28. Were you given any treatment for your neck pain?

Yes: ☐ No: ☐

If "Yes", please describe briefly the treatment you received:

If you require more space please use the final blank page of this questionnaire

29. Have you ever been grounded as a result of flight-related neck pain?

Yes: ☐ No: ☐

IF "NO" PLEASE GO TO SECTION 4 ON PAGE 10

30. If "Yes", please indicate for how long you were grounded:

Currently grounded: ☐	Less than 1 week: ☐	1 to2 weeks: ☐
3 to 4 weeks: ☐	More than 1month: ☐	

If you are currently grounded, please state the length of time you have been grounded for so far:

Length of current grounding period: _____

31. Have you ever taken any action in order to minimize or avoid flight-related neck pain?

Yes: ☐ No: ☐

If "Yes", please describe the type of action taken and if the action taken was effective:

If you require more space please use the final blank page of this questionnaire

Section 4: Comments

Please use the space below to add any additional comments:

If you require more space please use the final blank page of this questionnaire

Additional Space for Comments

Annex B: Selected pilot comments

- "Personally I think that while NVGs are a contributing factor to neck pain, the root cause seems to be the position of the CDU on the centre console. These require frequent and extended 'head down' time in an unnatural position.

  "Additionally, for taller pilots, the pedals do not adjust enough forward to allow a proper seating position, i.e., the seat must be positioned far back, which requires the pilot to lean forward in order to adequately reach the controls."

- "It is unclear that I can attribute my neck strain injury to one single flight. I would venture to guess it is a cumulative injury induced by the NVGs, counterweight, helmet weight, ergonomics of the cockpit and the repetitive nature of the flying sequences performed at a flight school such as 403 Sqn.

  "I would guess that 'doubling' the weight of the human head and forcing the neck to support it through a full range of motion is a lot to ask. Perhaps the equivalent of putting a 180 lbs backpack on a 180 lbs person and asking him to do various full range of motion tasks for a 2-3 hour period, day after day."

- "The questions on your survey are not specific enough. Most of my episodes of neck pain occurred well after flying (more than a week).

  "I am convinced that the flying weakens the tendons, ligaments and the muscle around my neck. However, the actual flying does not induce the episode of neck pain.

  "Ironically, most of my episodes occurred while I was on leave (Christmas, Summer Leave) and were induced by a sudden or 'non-traditional' movement of my head.

  "None of the treatments I have received so far were successful in reducing or eliminating the pain. Only the massage therapist provided temporary relief."

- "There is no doubt that flying with NVGs puts strain on the neck. The weight of the equipment and helmet is considerable. Flights are typically between 2 and 3 hours long, and when using 'HCCR' (hot refuelling) during mission or operations, flights can be 5 to 6 hours long. In my ~350 hours experience on NVGs I have personally increased my shirt size by two sizes! (While maintaining the same body weight.)

  "Typically pilots do no exercises to warm up neck prior to flight.

  "NVG hours logged in log book is not necessarily an accurate measure of the number of hours NVGs were worn. For example: I have ~470 hours of night flying on the CH146 but only ~350 hours NVG, however almost all night hours were logged with NVGs mounted on the helmet."

- "I used to use a counterweight. This caused some muscular fatigue, but the worst thing it contributed to was 'hot spots' at one or two places on my head while flying with NVGs (daytime flying without extra weight on the helmet got rid of the 'hot spots'). After approximately one hour of flight time with the NVGs and counterweight, the 'hot spots' became rather annoying.

  "As an experiment, I decided to do away with the counterweight to see if this would alleviate the 'hot spots' – and it did!

  "On getting rid of the counterweight, I found that my helmet rotated forward due to the moment arm the NVGs made. I had Safety Systems adjust my helmet nape strap snugly and I started using a chin cup. These two measures eliminated the rolling forward of the helmet on my head. The lesser weight also diminished muscular fatigue.

  "Perhaps neck injuries may be lessened in number if aircrew dispensed with the counterweight and ensured that their nape straps are properly adjusted and that they use a chin cup while flying with NVGs."

Annex C: Selected other aircrew comments

- "When seen by medical branch it is either pills for pain or told it is age and take Advil or Tylenol. Very rarely seen by the same physician for repeat pain."

- "My many pains have forced me to spend up to $2000 annually. I am a Reservist therefore I'm not covered under the military health plan. For my own well being I've incurred these expenses.

  "Note: This pain is paired up with my lumbar pain.

  "I always refused to go and complain to the military doctors with the fear of being 'grounded' and of course my being a supervisor I always tried to be a fine example.

  "Today my train of though has changed and with out any hesitation I would go and see the 'Doc', but it's 'too late for me'."

- "Most questions in this survey are directed toward neck problems, meanwhile the lower and mid back are as much of a concern. Because of my physiology my neck is very strong, but my lower back is the weak link.

  "I have been grounded due to a lower back problem associated with an increase in NVG operations on my part. The period of time was 3 weeks and the pain was considered severe for 2 weeks but got better due to physiotherapy and rest.

  "Actions I have taken to avoid this injury from occurring again is physiotherapy, weight lifting and I am currently taking glucosamine."

- "It is very difficult to pinpoint when all difficulties started. The signs and symptoms seem to worsen with time in the airframe.

  "I believe neck and back pain are a combination of many factors:

  - "NVGs/Helmet.
  - "Lack of support for the back which adds to the stress and fatigue level of the back. (FE seat is rag and tube.)
  - "The environment we work in and live in – weather is normally extreme, UN deployments and field time.
  - "Day to day physical workload of the 1 Wing crews (heavy equipment, trucks, tents, etc).

  "I have purchased orthopaedic pillows to minimize the discomfort but still the neck cracks, grinds and sometimes I have limited mobility.

"One final note: For a long term study, would it be possible to conduct MRIs on recent graduates of the flying phase (pilot, FE, mission specialist) and validate the deterioration of the spine over the long term."

List of abbreviations and acronyms

AESOP	Airborne Electronic Sensor Operator
CDU	Control Display Unit
FE	Flight Engineer
MRI	Magnetic Resonance Imaging
NVG	Night Vision Goggle
Sqn	Squadron
TACCO	Tactical Coordinator

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14. ABSTRACT

(U) Night vision goggles (NVGs) have become indispensable during night operations in the tactical helicopter community of the Canadian Forces. However, the additional mass of the NVGs and associated counterweight have been suggested as a cause factor in recent reports of neck strain within the CH-146 Griffon helicopter fleet. The present study sought to determine the rate of incidence and severity of NVG-induced neck strain experienced by CH-146 Griffon pilots and flight engineers. A questionnaire format previously used in US and UK studies was presented to Griffon aircrew as well as CH-124 Sea King aircrew (the latter acting as an external control group with limited NVG experience). A total of 196 Griffon aircrew (138 pilots and 58 flight engineers) and 85 Sea King aircrew (35 pilots and 50 other aircrew) responded to the questionnaire. Over 80% of Griffon pilots and flight engineers indicated they had experienced neck pain as a result of flying, significantly greater proportions than the respective Sea King aircrew in both cases. Griffon pilots indicated that the control display unit of the aircraft was a leading cause of neck pain while flight engineers indicated that out-of-door operations were a primary cause factor. Other factors are identified and discussed. Across all aircrew respondents there was a clear sense of distrust of, and perhaps dissatisfaction with, the medical care provided by the Canadian Forces. Recommendations to reduce flight-related neck pain are offered.

(U) Les lunettes de vision nocturne (LVN) sont devenues indispensables lors d'opérations nocturnes menées à l'aide d'hélicoptères tactiques des Forces canadiennes. Toutefois, certains rapports récents sur les douleurs au cou ressenties par les équipages d'hélicoptères Griffon CH-146 ont suggéré que le poids et le contrepoids de ces lunettes constituent un facteur important de fatigue pour le cou. L'étude a cherché à déterminer le taux d'incidence et la gravité de la fatigue du cou imputables au port de LVN par les pilotes et par les mécaniciens de bord d'hélicoptères Griffon CH-146. Un questionnaire initialement utilisé aux États-Unis et au Royaume-Uni a été remis aux équipages du Griffon et du Sea King CH-124 (ce dernier groupe faisant fonction de groupe de contrôle externe, en raison de son expérience plutôt limitée du port de LVN). Un total de 196 membres d'équipages d'hélicoptères Griffon (138 pilotes et 58 mécaniciens de bord) et 85 membres d'équipages d'hélicoptères Sea King (35 pilotes et 50 autres préposés de bord) ont répondu au sondage. Plus de 80 % des pilotes et mécaniciens de bord du Griffon ont indiqué qu'ils avaient éprouvé des douleurs au cou à la suite d'un vol – une proportion considérablement plus grande que dans le cas des équipages du Sea King. Les pilotes du Griffon ont indiqué qu'en plus des LVN, l'unité de commande d'affichage de l'aéronef était pour eux cause majeure de douleurs au cou. De leur côté, les mécaniciens de bord ont surtout cité les opérations porte ouverte comme facteur causal principal. L'étude a aussi permis de constater parmi les répondants un scepticisme – voire même peut-être un mécontentement très net – envers les soins médicaux offerts par les Forces canadiennes. Le rapport contient diverses recommandations susceptibles d'aider à réduire les douleurs au cou.

15. KEYWORDS, DESCRIPTORS or IDENTIFIERS

(U) neck pain; neck strain; neck injury; helicopter; rotary–wing